AMMUNITION CONTAINER CRITERIA

MILITARY TRAFFIC MANAGEMENT AND TERMINAL SERVICE

U.S. ARMY

TRANSPORTATION ENGINEERING AGENCY

MILITARY TRAFFIC MANAGEMENT AND TERMINAL SERVICE

FORT EUSTIS, VIRGINIA

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Fort Eustis, Virginia 23604
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SUBJECT: Ammunition Container Criteria

1. PROBLEM. To determine the transportability characteristics containers should have for safe and economical transportation of ammunition.

2. ASSUMPTIONS. Current types of export ammunition shipments are representative of those to be expected in the foreseeable future.

3. FACTS BEARING ON THE PROBLEM.

   a. Ammunition is a comparatively heavy commodity with a wide range of densities.

   b. Ammunition is palletized, skidded, or boxed in irregular, non-uniform configurations.

   c. Ammunition contains explosive materials that require special handling.

4. DISCUSSION. See ANNEX A.

5. CONCLUSIONS. A Department of Defense (DOD) ammunition container should meet the following criteria:

   a. A rugged 8-foot by 8-foot by 20-foot demountable van that can be transported intermodally (pages 31-32, 58, 73).

   b. Minimum internal volume of 990 cubic feet with minimum door widths and heights of 90 inches and 85 inches respectively (pages 14, 73).

c. Gross loaded maximum weight of 44,800 pounds with a tare weight not to exceed 6,400 pounds including the internal restraint system (pages 14, 57, 73).

d. Capable of coupling together in units of two to form a 40-foot unit (page 73).

e. Compatible with the MILVAN chassis (MIL-S-62076) for over-the-road movement (page 73).

f. End loading and side loading on both sides (pages 68, 73-74).

g. United States of America Standards Institute (USASI) MH-5.1 corner fittings on all corners (page 58).

h. Structured in steel, aluminum, fiberglass reinforced plywood or reinforced plastic (page 73).

i. Sufficient structural strength to withstand the static and dynamic loads, and the impact shock and racking stresses indicated in paragraph 5, Annex A. Capable of withstanding the weight of five like containers, loaded to gross weight capacity, in a stacked configuration (pages 32-45, 73).

j. Ventilated, weatherproof, and corrosion resistant (pages 52-57).

k. Internal mechanical load restraint system (pages 46-52).

l. Door locking device handles with provisions for padlocking and customs sealing (page 74).

m. Capable of use with a detachable, cushioned underframe for road and rail movement (pages 29, 74).

6. RECOMMENDATION. That the detailed criteria contained in Annex A be used as the basis for the design, development, testing, and production of an ammunition container.

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ANNEX A to Staff Study (Ammunition Container Criteria)

June 1970

DISCUSSION

1. Background.

a. Traditionally, ammunition has been shipped to oversea military commands in breakbulk ammunition ships. Movement from ammunition plants and depots in the continental United States (CONUS) to ammunition water terminals has been primarily by rail (boxcar); farside line-haul has been accomplished by highway, rail, or barge. This ammunition transportation system is expensive and time consuming, since it involves high port handling and overocean line-haul costs and requires multiple cargo handling at CONUS and farside ports, ammunition depots, and ammunition supply points (ASP's).

b. During December 1969 and January 1970, a test shipment of ammunition was made to the Republic of Vietnam (RVN) utilizing Sea-Land containers. Nine types of ammunition were loaded in 226 Sea-Land vans at inland CONUS ammunition plants. These vans moved by highway to Port Chicago, California, where they were loaded on the containership S.S. Azalea City and transported to Cam Ranh Bay, RVN. The containers then moved by barge and highway to various inland destinations. Project

TOCSA (Test of Containerized Shipments for Ammunition), as it was called, revealed that substantial savings in transportation time and funds were possible by shipping ammunition to oversea destinations in intermodal containers. It also revealed that various constraints limited the effectiveness of the 8-foot by 8-1/2-foot by 35-foot Sea-Land container to approximately 25-percent-overall-cube utilization. It was apparent that further study was needed to determine the characteristics a container should possess for the economical and efficient intermodal transportation of this type of commodity. The objective of this study, therefore, is to determine the transportability characteristics for an ammunition container. The study was conducted by Mr. R. Kennedy, Mr. H. J. Murphy, Mr. J. H. Edgerton, and Mr. H. K. Holman (Group Coordinator).

2. Study Approach.

a. It was recognized at the outset that the movement of ammunition in containers posed several unique problems.

(1) Ammunition is a commodity with a wide range of densities, which vary from 10 to 120 pounds per cubic foot, with most items in the 40-to-60 pound-per-cubic-foot range. Since the normal general cargo carried in intermodal land/sea containers approximates 20 pounds per cubic foot, it is obvious that an ammunition container must withstand abnormally high longitudinal, lateral, and vertical stresses.

This in turn requires an internal blocking and bracing system designed to restrain high g forces.

(2) The current ammunition packaging system lacks uniformity. Ammunition is palletized, skidded, or boxed in varying dimensions. Consequently, loading plans will vary from item to item.

(3) Since ammunition contains explosives, its storage, loading, and movement are closely controlled and subject to safety and security restrictions imposed by the various regulatory agencies; i.e., the Department of Defense (DOD), the Department of Transportation (DOT), the U.S. Coast Guard (USCG), the Bureau of Explosives, and others.

b. Due to the high cargo densities involved, it appeared that an efficient container for ammunition would, of necessity, be a special-purpose container with a relatively high tare weight. However, it was desirable that it be of standard exterior size, if at all possible, to facilitate its use with existing rail and road systems as well as with the Merchant Marine containership fleet. It was decided, therefore, to examine four potential container sizes:

Container	Interior Dimensions (w x h x l)
8' x 8' x 20' (USASI Standard)	90" x 85" x 19'4"
8' x 8-1/2' x 20'	90" x 91" x 19'4"

Container	Interior Dimensions (w x h x l)
8' x 4' x 20'	90" x 37" x 19'4"
8' x 8' x 6-2/3' (TRICON)	91-3/4" x 88" x 6'2-5/8"

These containers would be evaluated to determine weights, cubes, and payloads attainable with typical ammunition loads. Containers smaller than the TRICON (CONEX IV) were not considered, since the payload would be small and the tare weight to internal cube ratio would be unfavorable. Containers larger than 8-feet by 8-feet by 20-feet provide poor cube utilization for dense cargoes. For example, cargo with a 40-pound-per-cubic-foot density will "weigh out" an 8-foot by 8-foot by 20-foot standard container at 100-percent cube utilization, while a 29-pound-per-cubic-foot density weighs out an 8-foot by 8-foot by 30-foot container. Obviously, the high-density ammunition weighs out the larger containers with increasingly poor cube utilization as container lengths are increased.

c. Other factors of importance in evaluating any potential container are the constraints imposed by the various transportation modes, handling facilities, and capabilities throughout the transportation pipeline; safety requirements imposed by approving agencies; structural requirements to meet anticipated loads and stresses; internal load restraint system; and environmental criteria.

3. Ammunition Movement Data.

a. As a first step in the evaluation of possible containers, an analysis was made of ammunition export data for the period January through March 1970. During this quarter over 600,000 measurement tons (M/T) of ammunition moved through the four CONUS ammunition ports to oversea commands. Tonnages handled by ports are indicated below:

Port	Army	Navy	Air Force	Marine Corps	Total (M/T)
Earle, N.J.	19,535	-	1,899	-	21,434
Port Chicago, Calif.	14,890	2,005	148,063	-	164,958
Bangor, Wash.	33,759	44,173	23,733	8,070	109,735
Sunny Point, N.C.	243,800	1,427	61,119	14,099	320,445

NOTE: Data provided by MTMTS Area Commands

Since the export traffic handled by the Sunny Point Military Ocean Terminal amounted to over 50 percent of the total and included all shipper services, this traffic was considered to be representative of the total flow pattern.

b. A detailed examination was made of the manifests of the ammunition ships sailing from Sunny Point during the January - March period. Approximately 326,000 short tons (S/T) of cargo were lifted; the bulk of it to Southeast Asia. (See Appendix 1 for

detailed tabulation.) Army 155-mm and 105-mm ammunition plus Air Force 500-pound bombs accounted for over 50 percent of the total. These movement data (Appendix 1) were used as a basis for selecting a representative list of ammunition items by service to simulate stuffing the four ammunition container candidates. In addition to the large tonnage items in Appendix 1, the loading list was structured to cover a wide spectrum of sizes and weights. This list, comprising the 57 items tabulated below, was used to determine container cube, weight, and payload data.

Ammunition Items

Army

Item	Nomenclature
1	Fuze, N-277
4	Cartridge, 60-mm
5	Cartridge, 40-mm
10	Mortar cartridge, 4.2-in.
13	Charge, 155-mm
14	Projectile, 155-mm, how
15	Projectile, 8-in.
17	Cartridge, 50-cal
19	Cartridge, 5.56-mm

Ammunition Items

Army (contd)

Item	Nomenclature
21	Rocket, 2.75 whd
23	Grenade
25	Cartridge, 81-mm
27	Cartridge, 7.62-mm
28	Cartridge, 152-mm
32	Projectile, 175-mm
33	Flare, surface
35	Charge, 175-mm
36	Charge, 8-in.
37	Mine, ap
38	Projectile, 105-mm

Navy

Item	Nomenclature
1	Cartridge, 50-cal
2	Cartridge, 20-mm
3	Bomb, G.P., 250-lb
4	Fuze, bomb, M-128
5	Bomb, G.P., 500-lb
6	Demo kit, bangalore torpedo, M1A1

Ammunition Items

Navy (contd)

Item	Nomenclature
7	Warhead, 5-in. rocket
8	1,000-lb, low drag bomb, G.P.
10	Fins, bomb, M131A1
11	Mine, underwater, Mk55
12	Smokeless powder, cannon
13	Charge, demo, shaped, Mk45
14	Cartridge, 5"/54
15	Projectile, 5"/54
16	Cartridge, 8"/55
17	Projectile, 8-in. ap Mk21
18	Charge, propelling, M67
19	Projectile, 16-in. ap
20	Explosive section Mk, mod 1

Air Force

Item	Nomenclature
1	CBU 28/A dispenser and bomb
2	Cartridge, 20-mm, linked
3	Bomb, G.P., M117, 750-lb
4	Bomb, G.P., M118, 3,000-lb

Ammunition Items

Air Force (contd)

Item	Nomenclature
5	Flare, Mk45, mod 0
6	Bomb, G.P., blu 76/B
7	Bomb, fire, blu 27/B
8	Bomb, G.P., 100-lb AN-M30
9	Bomb, demo, blu 31/B
10	Bomb, 250-lb, Mk81
11	Fin assy, mau 94/B
12	Rocket and launcher assy, 2.75-in.
13	Bomb cluster, incendiary M36E1
14	Bomb, 500-lb, AN-M64
15	Bomb, G.P., 2,000-lb, AN-M66A2
16	Bomb, G.P., 1,000-lb, AN-M44
17	Flare, aircraft, Mk24, mod 3
18	Fuze, bomb, nose M904

4. Weight, Cube, and Load Data for Major Categories of Ammunition.

a. Utilizing the 57 items listed in paragraph 3, each of the four containers was stuffed by computer simulation to determine floor loads, payload in terms of number of pallets, and internal weight and cube utilization. The standard 8-foot by 8-foot by

20-foot container is limited by the International Standards Organization (ISO) and the USASI to a gross weight of 44,800 pounds. Assuming a tare weight approximately that of the MILVAN (4,400 pounds), the 8-foot by 8-foot by 20-foot container payload weight capacity was 40,400 pounds. This weight capacity was used also for the 8-foot by 4-foot by 20-foot and the 8-foot by 8-1/2-foot by 20-foot containers. The TRICON capacity of 15,000 pounds was used for that container. The internal cube of the USASI standard 20-foot container (1,040 cubic feet) was used for the 8-foot by 8-foot by 20-foot and appropriately adjusted for the 8-foot by 4-foot by 20-foot and the 8-foot by 8-1/2-foot by 20-foot containers. The TRICON cube of 350 cubic feet was used for that model.

b. Since pallets can seldom be loaded flush against the walls and ends of a container, a 1-inch clearance was allowed for both ends and sides. In addition, a 6-inch top clearance was permitted to insure that cargo could be forklifted into position. Since dunnage requirements will vary widely with the specific load and restraint system used, it was not feasible to apply a dunnage cube penalty. Thus, under actual conditions certain payloads may be somewhat smaller than those indicated in this study. In most instances, however, adequate space for dunnage remains after the container either weighs or cubes out. For

example, only 6 percent of the sample items loaded out to within 3 inches of the walls and 12 percent to within 3 inches of the ends.

c. It was necessary to examine the load and cube penalties associated with various possible modifications to the standard container. These modifications were those necessary to adapt a standard general cargo 8-foot by 8-foot by 20-foot container for ammunition carriage. Four modifications and combinations thereto were examined; i.e., internal tiedown rings, drop sides, side doors, and a cushioned underframe. The penalty associated with tiedown rings was estimated to be a reduction in internal height of 1-1/4 inches, a cube loss of 20 cubic feet, and a tare weight increase of 1,000 pounds. A container with both tiedown rings and side doors would incur a reduction of 1-1/4 inches in internal height and 1-1/2 inches in internal width, a 50-foot loss of internal cube, and a tare weight increase of 2,000 pounds. A drop side container with tiedown rings would likewise incur a 50-foot loss of cube but a 3,000-pound increase in tare weight. There would be no cube or tare weight penalty associated with a cushioned underframe, since the underframe would be detachable. When attached, the underframe would increase the exterior height only.

d. The factors outlined in the foregoing paragraphs 4a, b, and c were applied to each container and each item on the loading list. The results are on evaluation sheets grouped by Army, Navy, and Air Force items (Appendices 2, 3, and 4). The letters C and/or W in parentheses on each sheet indicate that the container "cubed out" or "weighed out." Each item was loaded both crosswise and lengthwise in each container. Method A indicates that lengthwise loading was the most efficient, while Method B indicates crosswise loading to be superior. The letter P after the number of tiers indicates a partial tier; i.e., 2 (P) is one full tier with a partial second tier.

e. Minimum and maximum floor loads from Appendices 2 - 4 are tabulated below. Average floor loads approximate 300 pounds per square foot.

Minimum & Maximum Average Loads

Army (20 items)		Minimum lb per sq in.	Maximum lb per sq in.
	TRICON	.28	2.25
	8' x 8' x 20'	.54	1.96
	8' x 8-1/2' x 20'	.54	2.00
	8' x 4' x 20'	.73	.73

Minimum & Maximum Average Loads

		Minimum lb per sq in.	Maximum lb per sq in.
Navy (19 items)			
	TRICON	.30	2.31
	8' x 8' x 20'	.23	1.95
	8' x 8-1/2' x 20'	.38	1.95
	8' x 4' x 20'	.52	1.23
Air Force (18 items)			
	TRICON	.32	2.23
	8' x 8' x 20'	.22	1.97
	8' x 8-1/2' x 20'	.22	1.98
	8' x 4' x 20'	.19	.74

Minimum & Maximum Point Loads

Army (20 items)			
	TRICON	.58	5.23
	8' x 8' x 20'	.58	4.39
	8' x 8-1/2' x 20'	.58	2.65
	8' x 4' x 20'	.88	.88
Navy (19 items)			
	TRICON	.58	3.88
	8' x 8' x 20'	.29	3.20

Minimum & Maximum Point Loads

Navy (contd) (19 items)		Minimum lb per sq in.	Maximum lb per sq in.
	8' x 8-1/2' x 20'	.58	3.76
	8' x 4' x 20'	.72	1.58
Air Force (18 items)			
	TRICON	.58	3.38
	8' x 8' x 20'	.33	3.20
	8' x 8-1/2' x 20'	.33	3.38
	8' x 4' x 20'	.23	.90

f. As mentioned previously, two loading methods were employed. In method A pallets or boxes were loaded with the long dimension lengthwise of the container, while method B employed crosswise loading. Method A was generally superior to method B (better cube utilization) in the 8-foot by 8-foot by 20-foot and 8-foot by 8-1/2-foot by 20-foot containers, while method B was preferable in the TRICON. The data are summarized by service in the following table.

Best Loading Plan

Army (20 items)		A	B	A or B
	TRICON	-	13	7
	8' x 8' x 20'	11	3	6

Best Loading Plan

		A	B	A or B
Army (contd) (20 items)				
	8' x 8-1/2' x 20'	10	6	4
	8' x 4' x 20'	1	-	-
Navy (19 items)				
	TRICON	3	13	3
	8' x 8' x 20'	13	4	2
	8' x 8-1/2' x 20'	13	4	2
	8' x 4' x 20'	1	2	1
Air Force (18 items)				
	TRICON	5	5	5
	8' x 8' x 20'	11	2	5
	8' x 8-1/2' x 20'	12	2	4
	8' x 4' x 20'	5	4	1

g. Cube utilization is particularly important in moving any cargo overseas in containers, since both port handling and overocean line-haul costs are based on cube rather than weight. Significant economic penalties are incurred when container cube is poorly utilized. Other considerations aside, the most desirable container for a particular commodity is that which provides the best cube utilization. The table below depicts the cube utilization spread by container, by service, for the 57 items tested.

Cube Range Utilization by Service, by Container

Container Size (feet)	Army Percent From	Army Percent To	Air Force Percent From	Air Force Percent To	Navy Percent From	Navy Percent To
8 x 8 x 6-2/3	19.98	56.94	28.68	69.98	28.1	56.61
8 x 8 x 20	32.11	65.84	33.81	81.04	36.13	70.85
8 x 8 x 20 WTR*	31.53	66.82	34.31	82.25	34.56	71.91
8 x 8 x 20 WTR/SD*	31.00	67.95	27.14	83.65	28.40	73.13
8 x 8 x 20 WTR/DS*	31.00	67.95	27.41	83.65	28.40	72.40
8 x 8-1/2 x 20	29.03	71.22	30.57	73.28	32.67	68.96
8 x 4 x 20**	61.96	61.96	40.24	71.14	31.62	54.00

Average cube utilization, weighted to reflect the tonnage of the various items flowing through Sunny Point, is listed below.

*Legend: WTR - With tiedown rings
SD - Side doors
DS - Drop side

**Although the cube utilization of the 8-foot by 4-foot by 20-foot side loading container was satisfactory, it was excluded from futher consideration since only 1 Army, 4 Navy and 10 Air Force items of the sample would fit in it.

Average Container Efficiencies

Army

Container (feet)	Mean cube utilization (percent)	Mean weight utilization (percent)
8 x 8-1/2 x 20	50.1	84.5
8 x 8 x 20	42.2	67.0
8 x 8 x 20 WTR*	42.6	67.8
8 x 8 x 20 WTR/SD*	43.0	68.6
8 x 8 x 20 WTR/DS*	42.9	69.4
8 x 8 x 6-2/3 TRICON	30.5	49.0

Air Force

Container (feet)	Mean cube utilization (percent)	Mean weight utilization (percent)
8 x 8-1/2 x 20	52.6	63.4
8 x 8 x 20	55.7	61.0
8 x 8 x 20 WTR*	55.3	61.1
8 x 8 x 20 WTR/SD*	54.3	61.1
8 x 8 x 20 WTR/DS*	53.9	61.1
8 x 8 x 6-2/3 TRICON	47.7	55.9

*See legend on page 19.

Navy

Container (feet)	Mean cube utilization (percent)	Mean weight utilization (percent)
8 x 8-1/2 x 20	48.9	71.0
8 x 8 x 20	47.3	65.0
8 x 8 x 20 WTR*	47.8	66.1
8 x 8 x 20 WTR/SD*	47.3	66.0
8 x 8 x 20 WTR/DS*	46.9	66.2
8 x 8 x 6-2/3 TRICON	40.9	51.5

The above data clearly illustrate the superior cube utilization obtainable with the 8-foot by 8-foot by 20-foot and the 8-foot by 8-1/2-foot by 20-foot containers. The 8-foot by 8-foot by 20-foot was more efficient for Air Force cargo, while the 8-foot by 8-1/2-foot by 20-foot was preferable for Army cargo. Either container would serve equally well for the Navy sample. The 8-foot by 4-foot by 20-foot side loading container was not included for further consideration since only 1 Army, 4 Navy, and 10 Air Force items would fit in it. Obviously, a side or end loading container of this size would be completely

*See legend on page 19.

inadequate for existing ammunition pallet sizes. Further consideration will be given later in the study to the possibility of using this container as a top loader.

h. With regard to the data in Appendices 2, 3, and 4, it is of interest to note that the majority of items cube out a container before weighing out (Appendix 5). This indicates that ammunition densities do not play as significant a role as might be expected. Pallet configurations are such that utilizing the full container payload capacity is impracticable, except for the most dense items such as bombs and large caliber projectiles.

i. After each container had been analyzed and tested individually to determine its cube efficiency, it appeared desirable to consider them in pairs. It was possible that a combination of container sizes would provide a significant increase in load efficiency. Containers were paired, therefore, in every possible combination and the optimum cube utilization averages tabulated (Appendix 6). Pairing the 8-foot by 8-1/2-foot by 20-foot with the 8-foot by 8-foot by 20-foot containers, in most cases, resulted in very small increases in effectiveness over that attainable with the individual container. In the case of Army cargo, however, an increase in effectiveness of 10 percent over the individual 8-foot by 8-foot by 20-foot was obtained. Analysis of the Appendix 6 data led to the conclusion that, in all probability, only minor efficiency gains would be attainable with a family of containers.

j. Having determined the load efficiency of the container models, the question arose as to a norm or maximum to measure these against. In short, what is good cube utilization for an ammunition container--given the current ammunition pallet sizes and weights? Certainly the norm of 75 percent for general cargo would not be applicable. With a fixed base of 8 feet by 20 feet, there was obviously some specific height that would provide the maximum attainable cube utilization. To find an optimum height, the base of the container was fixed at 8 feet by 20 feet and the external height raised in 1/2-inch increments through a range from 4 feet to 8-1/2 feet. Computer analysis indicated an optimum height of 70 inches with a cube utilization of 54 percent. Thus, it was apparent that one could not expect to obtain cube utilization factors much in excess of 50 percent in <u>any</u> container, unless the current pallet system is redesigned and standardized.

k. As indicated previously, the 8-foot by 4-foot by 20-foot container, when designed for side loading, has inadequate interior height to accommodate many ammunition items. The possibility existed, however, that with the additional usable interior height available with top loading, it might be a suitable container. The 6 inches allowed for headroom when loading from the side or end could be reduced to 1 inch when loading from the top, since forklift maneuver space is not required. A review of Appendices 2, 3, and 4 revealed that the additional items listed below could be

accommodated in the 8-foot by 4-foot by 20-foot container if configured for top loading. However, 15 Army, 8 Navy, and 4 Air Force items still would not fit into the container due to height limitations. Since 27 of the 57 items sampled could not be containerized in this size container, it was eliminated from further consideration.

Additional Items That Could Utilize The 8'x4'x20' Container If Configured For Top Loading (36 in. usable inside height)

Army	Air Force	Navy
Projectile, 155-mm, how	Bomb, 3,000-lb	Cartridge, 50-cal
Cartridge, 50-cal	Bomb, fire blu 27B	Cartridge, 20-mm
Cartridge, 5.56-mm	Fin, assy mau 94-B	Bomb, 250-lb
Rocket 2.75-mm, whd	Bomb, 500-lb	Mine, underwater Mk55
		Projectile, 5"/54
		Charge propelling M67
		Explosive section-mine

1. Ammunition item configurations are not well suited for the TRICON. Cube utilization for all services is significantly lower for the TRICON than that obtained with either the 8-foot by 8-foot by 20-foot or the 8-foot by 8-1/2-foot by 20-foot container. Also three of the Air Force bombs are oversize to this container. Its most serious deficiency, however, is its reduced payload vis-a-vis the

20-foot containers. Three TRICON's are designed to lock together to form an 8-foot by 8-foot by 20-foot container unit. The tables below compare the number of pallets that can be carried in the TRICON in its 20-foot configuration with those carried in standard 8-foot by 8-foot by 20-foot container. It is readily apparent that while the TRICON may provide distribution flexibility, it is not an efficient transportation vehicle for the intermodal movement of large quantities of ammunition. Inadequate cube utilization and poor payload capacity ruled it out from further consideration as a primary intermodal ammunition container.

TRICON Versus 8'x8'x20' Container Loading

Army Ammunition

Item	Three TRICON's (No. pallets)	8'x8'x20' (No. pallets)
Fuze	12	16
Cartridge, 60-mm	12	8
Cartridge, 40-mm	6	8
Mortar cartridge, 4.2-in.	9	15
Charge, 155-mm	6	12
Projectile, 155-mm	33	29
Projectile, 8-in.	69	59
Cartridge, 50-cal	12	16
Cartridge, 5.56-mm	12	16

Army Ammunition (Contd)

Item	Three TRICON's (No. pallets)	8'x8'x20' (No. pallets)
Rocket, 2.75 whd	12	16
Grenade	6	8
Cartridge, 81-mm	6	8
Cartridge, 7.62-mm	12	16
Cartridge, 152-mm	6	12
Projectile, 175-mm	45	39
Flare, surface	6	12
Charge, 175-mm	6	8
Charge, 8-in.	6	8
Mine, ap	6	8
Projectile, 105-mm	6	12

NOTE: In 16 items out of 20 the 8-foot by 8-foot by 20-foot container will carry a significantly higher payload than the TRICON in its 20-foot configuration.

Navy Ammunition

Item	Three TRICON's (No. pallets)	8'x8'x20' (No. pallets)
Cartridge, 50-cal	12	13
Cartridge, 20-mm	12	13
250-lb bomb, G.P.	12	16
Fuze, bomb	6	8

Navy Ammunition (Contd)

Item	Three TRICON's (No. pallets)	8'x8'x20' (No. pallets)
500-lb bomb, G.P.	6	10
Demo kit, bangalore torpedo	9	10
Warhead, 5-in. rocket	12	8
1,000-lb bomb, G.P.	9	13
Fins, bomb	12	8
Mine, underwater	12	16
Powder, cannon	12	15
Charge, demo	6	5
Cartridge, 5"/54	6	8
Projectile, 5"/54	12	10
Cartridge, 8"/55	6	8
Projectile, 8-in. ap	24	20
Charge, propelling	12	16
Projectile, 16-in. ap	15	13
Explosive section	6	8

NOTE: In 13 items out of 19 the 8-foot by 8-foot by 20-foot container will carry a higher payload than the TRICON in its 20-foot configuration.

Air Force Ammunition

Item	Three TRICON's (No. pallets)	8'x8'x20' (No. pallets)
Dispenser and bomb	Oversize	12
Cartridge, 20-mm	336	379
Bomb, G.P., 750-lb	18	23
Bomb, G.P., 3,000-lb	12	11
Flare	6	5
Bomb, G.P., blu 76B	Oversize	2
Bomb, fire	Oversize	6
Bomb, G.P., 100-lb	18	36
Bomb, 250-lb	12	8
Bomb, demolition	24	21
Fin assy	6	12
Rocket launcher assy	36	36
Bomb cluster, incendiary	18	19
Bomb, 500-lb	12	12
Bomb, G.P., 1,000-lb	18	24
Bomb, G.P., 2,000-lb	18	17
Flare, aircraft	6	10
Fuze, bomb, nose	162	180

NOTE: In 11 items out of 18 the 8-foot by 8-foot by 20-foot container will carry a higher payload than the TRICON in its 20-foot configuration. In only 5 of the 18 items is the TRICON superior in payload capacity.

m. It is probable that cube and/or payload penalties will be incurred in any container when various modifications are applied to adopt it for a special purpose. This is not to say that the modifications may not be desirable nor that they should not be made. It is important, however, to recognize that penalties exist and to estimate their magnitude so that "trade off" determinations can be made. The most significant possible design modifications to a standard general cargo container to meet ammunition containerization requirements were considered to be:

(1) The installation of tiedown rings and/or mechanical bracing for internal load restraint.

(2) Structural reconfiguration for either side doors or drop sides.

(3) The use of a cushioned underframe.

The cushioned underframe, conceived as a detachable unit, imposed no penalties on the container itself. The total unit exterior height for over-the-road or rail movement when the underframe would be used would be increased somewhat. As mentioned previously, the other potential modifications would impose both internal cube and load capacity reductions. Mechanical bracing penalties were estimated to be equivalent to those incurred with tiedown rings. Expressed in terms of payload, these penalties are tabulated below. Comparable penalties will exist with the 8-foot by 8-1/2-foot by 20-foot container.

Payload Penalty Incurred With 8'x8'x20' Container Modifications

Army Ammunition

Item	Standard container (No. pallets)	Tiedown rings	Side door	Drop side
Projectile, 155-mm	13	-1	-2	-2
Projectile, 8-in.	63	-1	-3	-4
Projectile, 175-mm	42	-1	-2	-3

NOTE: Of the 20 Army ammunition items surveyed, only the 3 above incurred a payload penalty when loaded in a modified USASI 8-foot by 8-foot by 20-foot container. The penalty ranged from 1.6 percent of payload to 6.5 percent.

Navy Ammunition

Item	Standard container (No. pallets)	Tiedown rings	Side door	Drop side
Cartridge, 50-cal	14	No penalty	No penalty	-1
Cartridge, 20-mm	14	No penalty	-1	-1
Charge, demo, shaped	8	No penalty	-3	-3
Projectile, 5"/54	11	-1	-1	-1
Projectile, 8-in.	21	No penalty	-1	-1
Projectile, 16-in.	14	No penalty	-1	-1

NOTE: Of the 19 Navy ammunition items surveyed, the 6 items above incurred a payload penalty when loaded in a modified USASI 8-foot by 8-foot by 20-foot container. The penalty ranged from 5 percent to 38 percent.

Air Force Ammunition

Item	Standard container (No. pallets)	Tiedown rings	Side doors	Drop side
Cartridge, 20-mm	400	-6	-16	-21
Bomb, G.P., 750-lb	24	No penalty	-1	-1
Bomb, G.P., 3,000-lb	12	No penalty	No penalty	-1
Flare, Mk45	10	No penalty	-5	-5
Bomb, demo	22	-1	-1	-1
Bomb cluster, incendiary	21	-1	-1	-2
Bomb, 500-lb	13	-1	-1	-1
Bomb, G.P., 2,000-lb	18	No penalty	-1	-1
Fuze, bomb, nose	216	-36	-36	-36

NOTE: Of the 18 Air Force ammunition items surveyed, the 9 items above incurred a payload penalty when loaded in a modified USASI 8-foot by 8-foot by 20-foot container. This penalty ranged from 1.5 percent to 50 percent.

n. Based on the characteristics of the 57-item ammunition sample and the considerations and factors outlined in preceding paragraphs, it was concluded that an 8-foot by 8-foot by 20-foot external configuration would most nearly meet the requirements for an ammunition container. The 4-foot-high container is too low to accommodate many types of ammunition, while the TRICON is inadequate due to poor cube utilization combined with a significant payload reduction. In terms of efficiency there is little to choose from between the 8-foot by 8-foot by 20-foot and the 8-foot by 8-1/2-foot by 20-foot containers. Although the 8-1/2-foot high container provides relatively good cube utilization

(better than the standard 8-foot by 8-foot by 20-foot for Army items), it is a non-standard size. While this height has admittedly been in use for many years by the largest United States ocean carrier, the military services would lose some flexibility in employment were they to use this container size for ammunition. On balance, then, the USASI and ISO standard 8-foot by 8-foot by 20-foot configuration was selected as the most suitable for ammunition containerization.

5. Design Loads.

a. Shock.

(1) Characteristics.

(a) The ammunition container loaded to full tare weight of 44,800 pounds must withstand a rail impact load of 10 miles per hour in each direction with no signs of failure or impending failure for the container, cargo, or restraining systems. The impact system will have a piggyback railcar configuration and impacts will be run in accordnace with TB 55-100 (Appendix 7).

(b) The fully loaded container must withstand corner and edgewise drops from a height of 12 inches and exhibit a 10 percent margin of safety for all major container and restraint components.

(2) Justification.

(a) The military specification for the MILVAN container requires a 2-1/2g longitudinal load. This is consistent with a 10 mile-per-hour impact for a container on flatcar (COFC) or trailer on flatcar (TOFC) system. To provide options to balance cushioning and structure economically, a velocity characteristic of 10 miles per hour was selected. The 10 miles per hour requirement with test mechanics as described in TB 55-100 will require a characteristic for ammunition containers the same as now required for general cargo containers carried on piggyback, autorack, and container railcars, many of which are now commercially available.

(b) The 12-inch drop tests are frequently specified for a limiting characteristic of vertical down shock in both military and commercial specifications. It is a requirement of many military specifications including MIL-P-116E. Again, the 12-inch requirement rather than a g-load requirement is chosen to provide for an intermix of cushioning and structural design.

(c) Shocks of other severities and occurring in other directions than those specified are normally associated with vibration-type input loadings. These will be covered in the general vibration characteristics to retain the shock and vibration association.

(3) Plan. The prototype container loaded to maximum capacity with inert ammunition and the cargo restrained in accordance with the proposed restraining system will comprise the test specimen. The test specimen will be tested in accordance with transportability test procedures for rail and terminal handling. Drafts of procedures are attached as Appendices 8 and 9. Type B, Failure Tests, are required to establish the failure load and the margin of safety for major system components.

b. Vibration.

(1) Characteristics. The container loaded with ammunition to both a maximum and a minimum practical gross weight shall be able to withstand the vibration consequent to 43 passes over a 2-inch washboard course and 43 passes over the spaced bump course. A positive margin of safety of 10 percent is required for all major structural components.

(2) Justification. According to TB 55-100, the highway vertical vibration is the most severe sustained vibration the cargo restraining system and container need withstand during an intermodal shipment. Project TOCSA verified these criteria findings. Damage consequent to highway vibration frequently causes an unsafe condition for sea shipment. During the ammunition test shipment, the highway portion of the shipment caused minor blocking failures and slippages that had to be

corrected on 50 out of 226 containers before the shipment could continue on the sea voyage. These minor failures would be serious in ocean movement where the loose cargo condition cannot be corrected or safety tolerated. Sea vibrations are occurring on the ammunition for a much longer time than highway vibrations but the frequency is slow (6 seconds per cycle) to be classified by a static characteristic. Rail vertical vibrations are less severe as shown in TB 55-100.

(3) Plan. The container loaded with a maximum and a minimum cargo of ammunition restrained in accordance with the proposed practice will comprise the test specimens. A simulated test specimen will be subjected to Method B, Laboratory Failure Tests, as described in Highway Transportability Test Criteria. The Method B test is to be conducted during the development and prototype stage for the ammunition container. The actual container loaded for both maximum tare weight and minimum practical tare weight is to be tested in accordance with Method A, Road Course Proof Test of the Highway Transportability Test Criteria, attached as Appendix 10.

c. Static Loads.

(1) Characteristics. The static design loads for this container are in most requirements, based on USA Standard, Specifications for Cargo Containers, USASI MH 5.1 [1/] and Military Specification Container, Cargo, MIL-C-52661 (ME), [2/] which are similar. The basic difference in the requirements, as regards static loads, for the ammunition container is that in the coupled configuration, the gross weight of the combined containers is not derated; it is equal to twice the gross weight for a single container. The static design loads in some of the specified loads are the same as in the reference publications; however, all of the specified loads for the container are equal to or more severe than those specified in the referenced publications.

(2) Justification. To insure acceptance of the container by the maximum number of carriers and to insure that the container is compatible with available handling equipment, it must comply with the minimum requirements of the USA Standard.

(3) Plan. The numbered references below are used in the tabulated material that follows.

1/ USA Standard, Specifications for Cargo Containers, USASI MH 5.1 - 1965, Revised to 1967. (If the latest edition is more severe, it will be applicable.)

2/ Military Specification Container, Cargo MIL-C-52661 (ME), 8 August 1969.

Design Load Specifications

Item	Load distribution	Force direction	Reference weight	Design load factor(g)	Requirement	Reference
Floor load cargo	Uniformly distributed	Acting downward, normal to the floor	(P)*, 60% uniformly distributed over the longitudinal center 10 ft; balance of load uniformly distributed over the remainder of floor	2.0	The container floor and associated components shall be capable of supporting the cargo when the container is handled or transported by any of the standard lifting or supporting points.	1/ and 2/
Floor load (wheeled vehicles)	Concentrated	Acting downward, normal to the floor	12,000-lb (6,000 lb maximum per wheel)	1.5 within 2 ft of door entrances; 1.25 elsewhere	The container floor shall be capable of withstanding concentrated loads imposed by industrial or other traveling vehicle with a maximum axle loading of 12,000 lbs. (Minimum wheel width shall be 7 in. with footprint area of not less than 22 sq. in. per wheel. Wheel center shall be assumed to be 30 in.)	1/ and 2/ similar except does not give a load factor

*Legend:

P - Maximum payload (gross minus tare weight); when two 20-foot containers are coupled the maximum payload is equal to twice the payload for one 20-foot container.

R - Maximum gross weight, 44,800 pounds; when two 20-foot containers are coupled the maximum gross weight is equal to twice the gross weight for one 20-foot container.

Design Load Specifications (Contd)

Item	Load distribution	Force direction	Reference weight	Design load factor(g)	Requirement	Reference
Front and rear panel loads	Uniformly distributed	Acting longitudinally outward, normal to ends	(P)*	0.4	Each end panel of the container shall withstand a uniformly distributed load of not less than 0.4 times the maximum payload of the container.	2/
Side wall loads	Uniformly distributed	Acting transversely outward, normal to walls	(P)*	0.6	Each side wall of the container shall withstand a uniformly distributed load of not less than 0.6 times the maximum payload of the container.	1/ and 2/ similar except for need
Corner structure loads	Concentrated eccentrically applied loads equally distributed between the four corner structures	Vertical compression	(R)*	9.0 (ea corner to take 1/4 of design load (coupled))	The container corner structure shall have sufficient strength to allow containers to be stacked six high (in the coupled configuration) when transported by ship and subjected to a vertical total force equivalent to 1.8g. It is to be assumed that the containers are stacked in cells, the guides of which in effect consist of four vertical angle bars or equivalent.	1/ and 2/ similar except that in the coupled configuration gross weight is derated

*See legend on page 37.

Design Load Specifications (Contd)

Item	Load distribution	Force direction	Reference weight	Design load factor(g)	Requirement	Reference
	Concentrated at pick-up points on four top and bottom corner fittings	Vertical tension	(R)*	2.0 (each corner to take 1/4 of design load (coupled))	The container corner fittings and associated components shall be capable of supporting the loaded container when lifted by any of the standard lifting devices (in the coupled configuration).	1/
Roof load	Uniformly distributed over an area 12 in. by 24 in. located anywhere on top of the roof	Acting downward, normal to the roof	400 lb	1.5	The container roof shall be capable of supporting two men working from the container roof.	1/ and 2/ similar
Restraint	Horizontal	Longitudinal	Single (R)*	5.0	A single container loaded to its maximum gross weight shall withstand 5.0g's external restraint applied in a horizontal plane in the longitudinal direction.	2/ (not covered in 1)
			Coupled containers (R)*	2.5	Two coupled containers loaded to maximum gross weight shall withstand 2.5g's external restraint applied in a horizontal plane in the longitudinal direction.	

*See legend on page 37.

Design Load Specifications (Contd)

Item	Load distribution	Force direction	Reference weight	Design load factor(g)	Requirement	Reference
Racking	Concentrated	Lateral and longitudinal in horizontal plane	35,000 lb	1.0	A single container shall withstand a lateral and longitudinal concentrated load of 35,000 lbs, applied separately for 5 minutes to each of the four top corner fittings when the bottom corner fittings are firmly anchored. The doors of the container shall show no signs of water leakage during the specified tests.	2/ (not covered in 1)

d. Test Requirements, Static.

(1) Characteristics. The test requirements for the container are similar to those described in the Military Specification Container, Cargo, (MIL-C-52661 (ME)) and others covered under the justification which follows. The basic difference being that gross weight is not derated for coupled containers. The test requirements in some of the specified tests are the same as in the referenced publications; however, in all of the specified tests the requirements for the ammunition container are equal to or more severe than those specified in the referenced publications.

(2) Justification. To insure that the container will be structurally strong enough to withstand the test requirements as established by existing national and international organizations, the tests must meet their minimum requirements; accordingly, the test plan has been developed to insure that this container meets the minimum requirements as set forth in the following references.

References:

1/ Military Specification Container, Cargo, MIL-C-52661 (ME), 8 August 1969.

2/ American Bureau of Shipping.

3/ Department of Transportation.

4/ Lloyd's.

5/ British Standards Institute.

6/ International Organization Standardization.

7/ Nippon Kaiji Kyokai

(3) Plan. The references shown on page 41 are used in the following tabulated material.

Requirements

Item	Single 20-foot long container	Two 20-foot containers (coupled)	Reference
Floor load (cargo)	The container floor shall support a load of 2 P* (60% uniformly distributed over center 10 ft.; remainder uniformly distributed over the remainder of the floor). The container shall be supported on its four bottom corner fittings, free to deflect for a period of not less than 5 min.		1/ (not required by 2/,3/,4/, 5/,6/,7/)
Floor load (wheeled vehicles)	The container floor shall be subjected to an axle weight of 12,000 lb (6,000 lb per wheel, wheel width not less than 7 in., contact area not less than 22 sq in., wheel centers 30 in. apart, width of test device not to exceed 48 in.). The truck or axle shall be maneuvered over the entire floor area and in and out of all doors. The container shall be supported on its four bottom corner fittings, free to deflect.		1/ (12,000-lb axle load specified in 2/,3/,4/, 5/,6/,7/)
Front and rear panel loads	The container shall be loaded to 0.4 P*, with water or air. The container shall be placed with the end to be tested down, supported on the four corner fittings, and free to deflect for a period of not less than 5 min. Both end walls shall be tested.		1/, (3/ and 4/ specify 0.4 P; others are less or permit alternates)
Side wall loads	The container shall be loaded to 0.6 P* with water or air. The container shall be placed with the side to be tested down, supported on the four corner fittings and free to deflect for a period of not less than 5 min. Both side walls shall be tested.		1/, (2/,3/, and 4/ specify 0.6 P; others permit alternates)

*See legend on page 37.

Requirements

Item	Single 20-foot long container	Two 20-foot containers coupled	Reference
Corner structure loads (stacking)		The two test-coupled containers shall be uniformly loaded to a gross weight of 1.8R* each. A superimposed load of 9R* shall be applied to the top four outer corner fittings to simulate a stack of six containers. The test containers shall be supported on the four outer bottom fittings on pads equal in area to the bottom fittings for a period of 5 min. The superimposed load shall be offset 1 in. laterally and 1-1/2 in. longitudinally with respect to the test containers in both longitudinal directions.	All references derate the weight for coupled containers
Lifting load (top)		The coupled containers shall be loaded uniformly to a gross weight of 2R* each and lifted vertically by the four top outer corner fittings. The containers shall be suspended for a minimum of 5 min.	All references derate the weight for coupled containers
Lifting load (bottom)		The coupled containers shall be loaded uniformly to a gross weight of 2R* each and lifted by the four outer bottom corner fittings. The lifting force shall be applied using one spreader above the roof. The angle of the lifting force shall be 30° from the horizontal (cables shall not bear against container side). The containers shall be suspended for a minimum of 5 min.	All references derate the weight for coupled containers

*See legend on page 37.

Requirements

Item	Single 20-foot long container	Two 20-foot container (coupled)	Reference
Roof load	A load of 660 lb covering an area of 12 x 24 in., shall be placed on the roof in such a manner as to produce the worst loading condition. The load shall remain in place for not less than 5 min.		1/,4/,5/,6/,7/
Restraint	The container loaded to a gross weight of R* shall be restrained in the longitudinal direction by securing the bottom two corner fittings at one end. A force equivalent to 5g shall be applied longitudinally at the bottom corner fittings on the opposite ends, first in compression and then in tension for a period of not less than 15 min each.		Reference 1/ derates the gross weight; other references not as severe
Racking	A load of 35,000 lb shall be applied to each top corner fitting separately in the lateral and longitudinal directions, while the bottom corner fittings are anchored. Each load shall be applied for 5 min. The doors of the container shall show no signs of water leakage during the tests.		1/; Others either not as severe or not applicable

*See legend on page 37.

6. Internal Restraint System.

a. The most satisfactory restraint arrangement was considered to be a system which meets the following criteria.

(1) Characteristics. The internal cargo restraint must have sufficient strength and function with a maximum allowable capacity of ammunition cargo and a center of gravity 40 inches above the floor to:

(a) Prevent relative movement between the cargo and the container.

(b) Weigh less than 1,000 pounds.

(c) Reduce the usable cargo space by not more than 10 percent.

(d) Provide for unloading with hand tools and a rough terrain forklift in not more than 30 minutes per container with a 3-man crew and a forklift operator.

(e) Reduce the cost of current blocking and bracing methods by 50 percent.

(f) Provide for restraint, loading, removing restraint and unloading from either end or side doors.

(g) Restrain all unitized or palletized ammunition currently in the system.

(h) Withstand, without fracture or loosening of the restraint members, a 10 m.p.h. rail impact with test procedures given in TB 55-100 and Rail Transportability Test Criteria.

(i) Withstand without failure of primary members a 12-inch corner and a 12-inch edge drop test in accordance with procedures given in Terminal Handling Transportability Test Criteria.

(j) Withstand, without failure or impending failure, a 1.5g vertical uploading of 10 second duration.

(k) Withstand the highway vibration environment listed for the container under Design Loads, Vibration in this report.

(2) <u>Justification</u>.

(a) The internal cargo restraint must be as strong as the restraint required of the containers because the relatively light construction of the doors, ends, walls and roofs of the containers will not provide for containing loose dense cargo. In rail and highway non-containment of the ammunition could precipitate damage to the entire train or road traffic. For sea, non-containment not only could damage cargo in nearby containers but could damage entire cell loads or perhaps endanger the safety of the entire ship.

(b) Ammunition presents special internal restraint problems due to its bullet-like shape. Cargoes of equal fragility, density and weight require a stringent internal restraint criteria but particular internal restraint systems are

needed for ammunition. The exact items should be tested to cover such factors as penetration and puncture and insure that the shapes are consistent with the restraint structure.

(c) Most ammunition cargoes are either single or double tiered. For internal restraint the double tiers present the most difficulty with regard to transportation environmental loadings. In Project TOCSA the pallet loads that were on the second tier experienced some loosening of the restraint due to highway vibrations encountered in CONUS. Although all the restraint damage was corrected before ocean shipment, inspection costs were high at the ocean terminal. An adequate restraint system must minimize inspection cost and time penalties between the highway and ocean shipment.

(d) Relative movement between the cargo and the container is not tolerable particularly in sea shipments. Although the g loadings are relatively low, they frequently persist for 20 days or more. The restraint is in a continual load and unload or load reversal condition. Movement of items within the cargo cannot be corrected at sea due to the inaccessibility of the cargo in the cells. Also, where as in other modes the vehicles can be stopped to correct for cargo looseness, the sea mode offers no opportunity

to stop the input environmental loadings. Relative movement of ammunition cargoes is now prohibited by regulations. This requirement should remain in effect.

(e) For the TOCSA test move, blocking and bracing or the internal restraint structure weighed approximately 1,500 to 2,000 pounds for a 35-foot long container load. The methods used were substantially extensions of conventional break bulk methods used in rail practice. The use of special internal restraint concepts for ammunition in containers should emphasize light weight. It is estimated that the weight of the internal restraint system should not exceed 1,000 pounds for an 8-foot by 8-foot by 20-foot container.

(f) It is essential to insure that the internal restraint system is located to provide the least space penalties to ammunition cargo. Conventional wood blocking and bracing systems use approximately 20 percent of the potential cargo cube. MTMTS studies have shown that an internal restraint system that would reduce the usable cube by 10 percent would produce a tangible and usable benefit. The most serious penalty is a reduction in container inside width. The most tolerable cube penalty is inside height and length reduction. The optimum arrangement, as regards space utilization, will utilize

some longitudinal and vertical space with a minimum taken from the inside width.

(g) Report from the first TOCSA test shipment indicated that a requirement exists for unstuffing ammunition containers in the field with a rough terrain forklift. The findings also include the need and recommendation to unstuff quickly. A preliminary study of the times and methods of unstuffing used in Vietnam indicates that 30 minutes unloading of an 8-foot by 8-foot by 20-foot container with a 4-man crew would be the minimum acceptable requirement to justify the requested built-in internal restraining equipment.

(h) Blocking and bracing costs were approximately $130 per container load for the TOCSA test. The costs vary for each item restrained. A built-in system should greatly reduce the carpentry work and materials. The characteristic selected was a 50-percent reduction in tiedown costs as a general average for all ammunition pallet loads.

(i) The TOCSA test report strongly recommended side doors for an ammunition container. Stuffing and unstuffing, side or end independently, must not be restricted by the internal restraint system.

(j) The internal restraint system must be capable of handling all types of ammunition that can now be handled by current blocking and bracing methods. The Military Services cannot afford to limit transportability by further restricting the types of ammunition that can be shipped in containers. A built-in system of internal restraint must have sufficient flexibility to eventually increase the types of container transportable ammunition expecially those entering the system in the future.

(k) Rail impact tests as recommended in TB 55-100 were selected as a requirement for transportability compliance. This provides for a reproducible base and the establishment of interchangeable failure loads and margins of safety. In general, the restraining system is required to withstand the same rail shock load as the container. These tests are consistant with ISO and commercial piggyback test requirements. It is the intent that the internal restraint test for rail shocks be the same test as those conducted for the containers, with additional instrumentation applied to the internal restraint and the cargo.

(l) Twelve-inch cornerwise and edgewise drops are characteristics required of the container that are extended to the cargo to balance the system strength wise.

(3) Plan. All internal restraint characteristics will be satisfied by analysis in the design stage. The prototype containers are to be tested against the criteria with all principal failure loads and margins of safety determined. Transportability test procedures are contained in Appendices 8, 9 and 10.

7. Environmental Criteria.

a. Temperature.

(1) Characteristic. Ventilation shall be provided to permit the free circulation of air throughout the container to maintain reasonable temperatures.

(2) Justification.

(a) With reference to storage and handling of chemical munitions, AFM 71-4 states "When stored outdoors chemical munitions should be covered with tarpaulins and stacked to permit free circulation of air."

(b) TM 9-1300-206 covers specific regulations governing ammunition as follows:

1. Under Regulations for Handling Ammunitions and Explosives is stated, "If it is necessary to leave boxes (of ammunition) in the open temporarily they should be covered with a flameproof paulin, so placed that there is free circulation of air through the stack."

2. Under Fire Protection, "Some explosives ignite at temperatures substantially lower than those required to ignite wood, paper, or fabrics. . . . Therefore, every effort will be made to maintain normal temperature surrounding ammunition and explosives."

3. Under Safety Rules, "When specially constructed magazines are not available, the building used must afford suitable protection against moisture and excessive changes in temperature and have means for adequate ventilation. . . . Ammunitions should be . . . arranged so that free circulation of air beneath and throughout the stack is possible."

(c) Coast Guard Rules and Regulations for Military Explosives and Hazardous Munitions, CG 108, covers the following:

1. Transportation or Storage of Explosives . . . on Board Vessels. Under Ventilation of Magazine, "A magazine that is not fitted with ventilating ducts to the atmosphere shall be ventilated by omitting the top course of boarding on the sides of the magazine to provide a clear space at least 1 inch and not more than 6 inches below the lower flange . . . within the compartment . . . ."

2. In the table on Classification, Handling, and Storage it is stated that, "It is important to stow in

locations not subject to temperatures above 100 degrees Fahrenheit." This statement is made under the column head "Stowage" for chemical ammunition HC filled, chemical ammunition WP or PWP filled, and chemical ammunition nonlethal.

(d) USATEA Report 70-8, Engineering Report, Predicting High Temperatures Inside Cargo Containers, states that at the time the ambient air temperature at the Tropic Test Center was 93 degrees Fahrenheit, the temperature build up inside a closed CONEX container was 123 degrees Fahrenheit 6 inches below the roof and 135 degrees Fahrenheit on the south wall of the container. This information was referenced to point out that temperature build up inside a closed container can become significant.

(3) Plan.

(a) That 4.25 square feet net ventilation be provided in each end of the container both at the top and bottom, or a total net ventilation of 17 square feet. For ventilator with 50 percent free area, the gross ventilation area required will be 34 square feet.

(b) This plan is based on an 8-foot by 8-foot by 20-foot long aluminum container backed with plywood, a 10-degree Fahrenheit temperature differential, still air, and the top and one side of the container exposed to the sun.

(c) Based on a calculated risk, the ventilation requirements may be changed; however, any decrease in ventilation will result in a corresponding increase in container temperatures when exposed to the most critical temperature conditions.

b. Weather.

(1) Characteristics.

(a) Lightning Protection. The container shall be properly equipped with a lightning protection system.

(b) Moisture. The container shall be rainproof.

(c) Static Electricity. The container shall be constructed to prevent the build up of static electricity.

(d) Sparks. All tools, moving parts, materials for cleaning shoes before entering the container, or other spark-producing hazards shall be of non-sparking materials.

(2) Justification. Reference TM 9-1300-206, Care, Handling, Preservation and Destruction of Ammunition.

(a) Lightning. "Buildings and structures used for the manufacturing, processing, handling or storage of explosives and ammunitions shall be equipped with a lightning protection system."

(b) Moisture. "When especially constructed magazines are not available, the building used must afford suitable protection against moisture, etc."

(c) Static Electricity. "Charges of static electricity can be accumulated on a person and on explosive material. . . . The discharge of static electricity is considered a serious hazard in the presence of certain exposed explosives, dust-and-air . . . ."

(d) Sparks. "Sparks may be caused by striking iron or steel nails or metal containers with iron or steel tools or by nails in shoes striking flint, pebbles, or grains of sand, or nails in the floor. Such sparks, small as they are, have caused disastrous explosions of black powder or the dust of other explosives which ignite easily. This hazard is the basis for requiring tools of brass, copper, or other nonsparking materials, cleaning mud and dirt from shoes before entering magazines or operating buildings, and wearing approved safety shoes when exposed explosives are present."

(3) Plan.

(a) Lightning. A lightning protection system, conforming to an acceptable code, shall be installed.

(b) Moisture. The container shall meet weatherproofness tests similar to that prescribed in MIL-C-52661 (ME), Military Specification on Container, Cargo, except that there will be additional requirements for the weatherproofness of the ventilation system.

(c) Static Electricity. The container shall meet suitable electrical conductive or resistance tests to ascertain that there can be no build up of static electricity.

(d) Sparks. The material of all parts or items associated with the container shall be of nonsparking material where necessary to eliminate the hazard of sparking.

c. Corrosion.

(1) Characteristic. The container shall be constructed of such corrosion resistant materials that maintenance, as a result of corrosion, will be a minor concern.

(2) Justification. Corrosion of materials is of special concern when they are exposed to the natural outdoor environments.

(3) Plan. Consideration shall be given to the Salt Fog Tests of MIL-STD 810B or similar tests to obtain an indication of the corrosion resistance of the container materials both individually and combined as they will be in the fabrication of the container.

8. Constraints.

a. Characteristics.

(1) Overall dimensions and weight of the container must be as follows:

Height - 8 ft
Width - 8 ft
Length - 20 ft
Weight - 44,800 lbs (20 L/T)*

*L/T - Light ton

(2) The container must be transportable by all surface modes of transport, and it must be compatible with cargo handling equipment throughout the storage and transportation system. Compatibility also includes sufficiency in the following areas:

(a) Door opening configuration.

(b) Floor bearing strength.

(c) Container floor aligned with or above door sills.

(3) Container must be equipped with ISO Standard corner fittings. It must be accessible from both sides and the rear for stuffing and stripping operations.

(4) The container must be approved for use in transporting ammunition (all classes) via all surface modes of commercial and military transportation.

(5) The container must be splashproof.

b. Justification.

(1) Highway. Under the constraints pertinent to the highway mode, the 8-foot by 8-foot by 20-foot, 44,800-pound design qualifies for generally unrestricted movement on a worldwide basis. Investigation of 136 states, provinces, and countries reveals that in 82 percent of the areas examined, the recommended configuration can be moved without restriction. Of the remaining 18 percent, some restriction is imposed on the

physical dimensions or maximum gross weight of the container. In some cases, restrictions are based on legalistic limitations rather than the physical capacity of the highway system in the particular area. In many such instances, the proposed 8-foot by 8-foot by 20-foot container can be readily moved over the highway system with permission of the area legal authorities. An investigation of the extent to which such authorization can be obtained is beyond the scope of this study; however, experience indicates that cargo with the dimensions specified is transportable on highway systems throughout the world. This experience is reinforced by the fact that the 8-foot by 8-foot by 20-foot, 44,800-pound container conforms to the ISO Standard for containers. Examination of the impingement of the 8-foot by 8-foot by 20-foot container on restrictions indicates that:

(a) 48 percent of the restrictions involve weight limitations.

(b) 42 percent of the restrictions involve height limitations.

(c) 24 percent of the restrictions involve width limitations.

(d) 20 percent of the restrictions involve length limitations.

It should be noted that 32 percent of the incursions of the restrictions involved overages of 10 percent or less. The restrictions discussed above do not take into consideration the impact of inclement weather or national disaster.

Appendix 11 is a listing of over-the-road limitations for various areas of the world. This information is excerpted from Containerization International, 1970 Yearbook, pages 200-204.

(2) Rail. The 8-foot by 8-foot by 20-foot, 44,800-pound container qualifies for generally unrestricted movement on the railway systems of the world. Investigation of 122 states, provinces, and countries indicates that the proposed size for this container can be transported on the railway systems without restriction in 85 percent of the countries. The proposed configuration will require a permit for movement in the remaining countries. The only areas in which difficulty can be anticipated are those areas of countries (e.g. Portugal) which are served by narrow gauge railway only. However, based on experience in handling oversized shipments, it is felt that in the rare cases where the narrow gauge rail is limited to a smaller configuration, the country's highway or inland waterway system is capable of handling the 8-foot by 8-foot by 20-foot, 44,800-pound container. Containers of this size which are within the ISO Standard for dimension and weight are currently being handled on rail systems in many areas of the world. The following table lists areas of the world which can accommodate by rail a loaded container, 8- by 8- by 2-feet, weighing 44,800 pounds.

Areas of the World That Can Accommodate by Rail a Loaded 8-x8-x20-ft, 44,800 lb Container

Area	Max. Axle Load	Remarks
Austria	20 tons	
Belgium	24 tons	
Bulgaria		
Denmark	14 to 20 tons	
France		
Greece		
Hungary		
Luxembourg		
Poland		
Romania		
Czechoslovakia		
Turkey		
Sweden	20 tons	
Switzerland		
Netherlands	21 tons	
Italy		
Germany	20 metric tons	
Norway		
Yugoslavia		
Morocco		
Algeria		

Areas of the World That Can Accommodate by Rail a Loaded 8-x8-x20-ft, 44,800 lb Container (contd)

Area	Max. Axle Load	Remarks
Tunisia		
Syria (E. Allepo)		
U.S.S.R.		
United States (50 states incl Alaska)		
Canada (11 provinces)		
Mexico		
Finland	59.5 tons	
Japan (Tokaido Line)	19 tons	
Northern Ireland		
Republic of Ireland	8 to 18.5 tons	Will take low car.
Portugal	19 tons	Broad gauge can accommodate container; narrow gauge cannot.
Spain	22 tons	Broad gauge can accommodate container.
Argentina		5 - 6 gauge can accommodate container. 4 - 8-1/2 gauge can accommodate container.
Brazil		Information unavailable.
Peru (Ferrocarril Central)	13.4 to 18.3 tons	

Areas of the World That Can Accommodate by Rail a Loaded 8-x8-x20-ft, 44,800 lb Container (contd)

Area	Max. Axle Load	Remarks
Uruguay State Railway		Will require permit.
Algeria		Standard gauge can accommodate container.
Congo	15 tons	Will require permit.
East Africa	10 to 22 tons	Will require permit.
Ghana	12-1/2 to 16 tons	Will require permit.
West Africa	13 to 16.2 metric tons	Will require permit.
Malawi		Will require permit.
Nigeria		Will require permit.
Sierra Leone	5 tons	Will require permit.
South Africa	10 to 22 tons	Will require permit.
Ceylon		
Taiwan		Will require permit.
India	19 to 28.5 metric tons	
Indonesia	8 to 13-1/2 tons	Will require permit.
Iraq	17 tons 12 tons	Standard gauge. Metric gauge; will require permit.
Israel		Standard gauge.
Malaysia	16 tons	Will require permit.

Areas of the World That Can Accommodate by Rail a Loaded 8-x8-x20-ft, 44,800 lb Container (contd)

Area	Max. Axle Load	Remarks
Pakistan		Broad gauge.
Philippines	35,000 pounds	
Turkey		Will require permit.
Australia Commonwealth Railways		
New South Wales	22.6 tons	May require permit.
Queensland	15 tons	Will require permit.
South Australia	22 tons	Will require permit.
Victoria	17 tons	Will require permit.
West Australia	10 to 14 tons	Will require permit.
New Zealand	16 tons	Will require permit.

(3) Army Air. Both the CH-47 and CH-54 helicopters are capable of sling loading the 8- by 8- by 20-foot configuration. However, neither is capable of lifting the 44,800-pound maximum gross weight of the proposed container. At this time, no United States helicopter is in the production or meaningful developmental process which can accomplish such a lift. Considerable work has been done both experimentally and operationally in carrying equipment and containers even larger than 8- by 8- by 20 feet; therefore, physical measurements of the container are not limiting factors.

(4) Terminals. The primary constraints imposed on the container size by terminals involve handling equipment and facility layout. Handling equipment is discussed in detail in the paragraphs below. Since the proposed configuration is in accordance with ISO Standards and is relatively small, the problem of facility layout for the handling thereof is simplified. Any terminal facility designed and constructed for handling containers in volume will be capable of accommodating the 8- by 8- by 20-foot container. Also, terminals not specifically designed as container-handling facilities can obviously handle the 8- by 8- by 20-foot container more readily than a larger container. Efficient logistical planning and transportation coordination will prevent destination port congestion, permit immediate dispersal of the loaded containers to the forward ammunition supply point (ASP) locations, and thereby alleviate the requirement for large holding areas for ammunition-filled containers at terminal locations. Such rationale supports very closely the conceptual "Inventory in Motion" program.

(5) Inland Waterway. An examination of available information indicates that the 8- by 8- by 20-foot, 44,800-pound container configuration is readily transportable via the primary inland waterway systems of the world. This consideration does not evaluate the impact of weather factors on the inland waterway transportability question.

(6) Handling Equipment.

(a) Movement of Containerized Ammunition. The proposed movement of ammunition in 8- by 8- by 20-foot containers is based on the use of commercial transportation carriers' transport equipment and facilities for the major portion of the movement. Specialized container handling equipment is available at container ports. This equipment includes overhead gantry or A-frame cranes capable of lifting stuffed containers from shore to ship in a 2-1/2-minute cycle per container. Transfer vehicles are available to more containers by side, top, or straddle-lift from one point to another to effect efficient container mode transfer. Marshalling or holding-yard systems are established worldwide to stage containers for sea lift or inland movement. However, no ammunition port has a shore based system in being capable of handling containers.

(b) Feasibility of Containerizing Ammunition. Project TOCSA, conducted in December 1969 through January 1970, pointed out that the transport of containerized ammunition was feasible. However, self-sustaining ships were used. In fact, self-sustaining containerships had to be used because no ammunition outport is equipped with

shore-based container cranes nor is any oversea ammunition pier equipped with shore-based container cranes. In addition, no military material handling equipment is available to effectively lift or transfer loaded ammunition containers weighing 44,800 pounds (20 L/T). The use of ISO standard external dimensions and corner fittings increases the ability of the commercial carriers to handle the ammunition containers and permits off-the-shelf procurement of material handling equipment by the military for use in handling ammunition containers where required.

(7) Ammunition Plants and Forward ASP's. Many outloading facilities at ammunition plants in CONUS are depressed rail loading docks with a revetment parallel to the tracks. Boxcars on these tracks are side-loaded with palletized ammunition by forklifts. This system of outloading will require 8- by 8- by 20-foot ammunition containers to be delivered to the ammunition plants via rail and be accessible for loading through either side via forklift. In addition, the container must be inspected for transport via rail when loaded with any class of ammunition. The unstuffing of ammunition containers at forward ASP's is done under various conditions depending on the type and amount of material handling equipment available and the combat situation. Normally, the only material

handling equipment available are rough terrain forklifts. Side and rear access to the ammunition container will greatly increase the ability of the forward ASP's to strip containers with the material handling equipment and manpower locally available.

(8) Ship Lift Capacity. The present worldwide containership fleet of over 260 vessels includes 53 vessels with an onboard crane capacity of 20 L/T or more. Eighteen of these vessels are not capable of carrying the 8- by 8- by 20-foot container (Sealand, 35-foot container size only). This leaves 35 vessels capable of stowing or discharging 8- by 8- by 20-foot containers weighing 20 L/T. However, U.S. Coast Guard safety practice requires that cranes lifting ammunition be rated 50 percent in excess of expected tonnage to be lifted. Thus, for a 20 L/T lift, the onboard crane must be rated at least capable of lifting 30 L/T. The present containership fleet includes only 20 such ships. If the stowage configuration of these self-sustaining ships requires stowage of containers in a 40-foot configuration, then the onboard crane must be rated to lift 60 L/T. The present containership fleet includes only four vessels capable of lifting 60 L/T with ship's cranes. The containership fleet under construction and planned for construction includes only 14 self-sustaining vessels. The basic reason for this is cost. (Initial cost of crane and

operational and maintenance costs of crane compared to hours used and loss of revenue to owner due to dead weight of crane.) The dependence of a containerized ammunition transportation system on shore-based cranes would severely restrict the number of vessel discharge locations for ammunition ships. No shore-based container cranes are known to exist at any oversea ammunition discharge pier. Under normal conditions no port will permit the discharge of ammunition (except small arms) at general dry-cargo piers. Various conventional shore-based cranes can be used to discharge container ships. However, except for slow cycle floating cranes of 30 to 100 L/T capacity, no cranes capable of lifting 20 L/T containers of ammunition are known to exist which could, with even minimum effectiveness, discharge such containers. Loading of non-self-sustaining containerships at CONUS ammunition ports is also difficult since no shore-based container cranes exist at the ammunition loading piers. The effective cycle of a containership crane is 2.5 to 4 minutes per load/unload container cycle.

(9) Ship Load Capacity. The present containership fleet includes over 260 container vessels, which range from partial containerships capable of stowing 18 containers to full containerships capable of stowing 1,300 containers. However, except for partial containerships and some conventional ships converted

to containerships, no full containership can transport its listed container stowage capacity of fully stuffed containers weighing 44,800 pounds or 20 L/T. The average containership is designed to stow its full capacity of containers averaging 13 L/T per container. This presents the problem of ascertaining the actual capacity of each containership to be utilized in the system in order to compute the true cost saving of the ocean voyage segment of the ammunition container movement system.* Appendix 12 is a list of containerships extracted from Janes Freight Containers, 1969-1970, and The Container Ship Register, published by A. S. Shipping Consultants, Fr. Masine Plass 6, Oslo 1, Norway. These ships range in loaded draft from 17 to 31 feet, length from 222 feet to 675 feet, deadweight from 2,350 tons to 30,000 tons, and speed from 12.5 knots to 21 knots. In addition to the vessels listed in Appendix 12 over 250 other container vessels are presently under construction, 50 vessel conversions are on order and 80 vessels are in various stages of negotiation for construction.

c. Plan. Continue to monitor developments which might influence the constraints imposed on the ammunition container design. As information regarding such developments becomes available the constraint data contained herein will be updated accordingly.

*Hull Design Department, Newport News Shipbuilding and Dry Dock Company, source of full containership average container design tonnage.

9. Safety.

a. The transportation of ammunition must conform to certain safety standards prescribed by the Government regulatory agencies including the DOD, DOT, and the USCG. Brief descriptions of the most important regulations are contained in Appendix 13.

b. Compatibility requirements, explosive quantity/distance standards, and other safety factors must, of necessity, limit the methods by which ammunition is moved. Certain current regulatory limitations, however, have a specific impact on the use of ammunition containers. These safety constraints in their present form would severely limit the efficiency and flexibility of any ammunition container transportation system. Areas of particular significance are considered to be the following:

(1) DOT regulations (Section 173.56 (c) and (c) (1)) require approval by the Bureau of Explosives (Association of Ammerican Railroads) of all loading, blocking, and bracing methods used for rail and highway shipment of unboxed (loose or palletized) explosive projectiles, torpedoes, mines or bombs--each exceeding 90 pounds in weight and 4-1/2 inches in diameter.

(2) DOT regulations restrict the shipping of different types of ammunition in the same container.

(3) USCG ammunition compatibility requirements are applicable to each hold of a ship. DOT compatibility requirements are less restrictive in that they are applicable to each container load only.

(4) USCG regulations (46 CFR, Part 146-29.11 (64)) limit the transportation of military explosives and ammunition overwater in containers (seavan type) to Coast Guard classes I and II with the exception of class II-J. Thus, the following major categories of ammunition items could not be containerized:

(a) Chemical ammunition, TH incendiary, composition filled.

(b) Various types of fuzes, detonators and primers.

(c) Fixed and semifixed ammunition with explosive projectile.

(d) Various types of separate loading projectiles.

(e) Various types of large bombs.

(f) Chemical ammunition with lethal and nonlethal gases.

c. It is apparent that the USCG regulations will require revision if the full economic advantages of ammunition containerization are to be gained. The safety problems associated with the use of ammunition containers are further complicated by the United Nations proposal to publish worldwide ammunition shipments compatibility and safety requirements. These may affect current United States regulations and require further revisions thereto.

10. General Ammunition Container Criteria.

a. A rugged 8-foot by 8-foot by 20-foot demountable van that can be transported intermodally.

b. Minimum internal volume of 990 cubic feet with minimum door widths and heights of 90 inches and 85 inches respectively.

c. Gross loaded maximum weight of 44,800 pounds, with a tare weight not to exceed 6,400 pounds including the internal restraint system.

d. Capable of coupling together in units of two to form a 40-foot unit.

e. Compatible with the MILVAN chassis (MIL-S-62076) for over-the-road movement.

f. End loading and side loading on both sides.

g. USASI Standard MH-5.1 corner fittings on all corners.

h. Structured in steel, aluminum, fiberglass reinforced plywood, or reinforced plastic.

i. Sufficient structural strength to withstand the static and dynamic loads, and the impact shock and racking stresses indicated in paragraph 5. Capable of withstanding the weight of five like containers loaded to gross weight capacity in a stacked configuration.

j. Ventilated, weatherproof, and corrosion resistant.

k. Internal mechanical load restraint system.

l. Door locking device handles with provisions for padlocking and customs sealing.

m. Capable of use with a detachable cushioned underframe for road and rail movement.

11. Summary.

a. Ammunition has several unique characteristics that pose significant containerization problems. It is an extremely dense commodity, packaged in varying configurations, and requires special handling in conformance with accepted safety standards for explosives. An ammunition container, then, must be structurally capable of carrying concentrated loads over an intermodal transportation network with a minimum of load shifting. Its cube utilization, by which container effectiveness is normally measured, can at best approximate only 55 percent because of the existing palletization system. Future standardization and pallet redesign could materially improve this utilization factor.

b. Based on a sample of 57 typical ammunition items, this study points to an 8-foot by 8-foot by 20-foot demountable, side loading container as the most suitable for ammunition. Due to the tare weight penalty, side doors would be preferable to a drop side design. The payload penalty imposed by side doors is moderate. The container payload capacity should approximate 19 short tons, with roughly 1,000 cubic feet of internal volume. Cube utilization for most items should approximate 50 percent. It should

be habitually used with a cushioned underframe for road and rail movement.

c. An internal mechanical restraint system will be required to control the lateral, longitudinal, and vertical forces that will act on the ammunition load. A mechanical built-in restraint system would minimize the amount of dunnage required and reduce the excessive time now utilized to prepare a load for shipment using conventional blocking and bracing methods.

d. Paragraph 5 outlines the testing program required to insure that the container will function in a safe and efficient manner and withstand the anticipated g forces.

e. Road limitations exist in some foreign countries. In general, these are legal rather than physical. Special container movement authorizations will be required in certain areas. Within CONUS ammunition containers in the coupled 40-foot configuration will generally exceed state highway maximum vehicle weight limitations for five axle loads. In all probability, therefore, the container will not normally make highway movements as a 40-foot unit. The U.S. Coast Guard requirement that a ship's boom must be rated 50 percent in excess of the gross container weight to be lifted is a severe limitation. At present, self-sustaining containerships must be used for containerized ammunition due to lack of container facilities at CONUS ammunition ports. Many of these ships cannot be utilized for ammunition until the Coast Guard lift limitation is modified.

f. This study has examined in some detail the various factors that infringe upon and limit the efficient operation of an ammunition container system. None of these restrictions appears to be insurmountable; most of them can be minimized or reduced to acceptable proportions. There is every reason to believe that an efficient, safe, and economical ammunition containerization system can be developed in the near future.

g. Substantial economies can be anticipated from ammunition containerization. The following are examples:

(1) Project TOCSA revealed that port handling costs at Port Chicago, California, could be reduced from $16.50 to $3.37 per measurement ton. Port handling costs at Cam Ranh Bay, RVN, were reduced from $7.08 per measurement ton to $.33.

(2) The 1st Logistical Command, RVN, estimates that containerized shipments of ammunition will reduce theater order and ship time by 1 day; a saving of $5,000,000 (1st Logistical Command After Action Report, Project TOCSA).

(3) Sunny point Military Ocean Terminal, North Carolina, estimates a reduction in port handling costs from $16.11 per measurement ton to $4.64 when ammunition is containerized.

(4) The development of a container berth at Sunny Point Ocean Terminal combined with containerized ammunition shipments would save 4 days in ships' turnaround time, reduce longshoreman labor costs by $60,000 per ship, and virtually eliminate tl blocking lumber at $25,000 per ship (Sunny Point estimate).

APPENDIX 1 to ANNEX A to Staff Study (Ammunition Container Criteria)
June 1970

Ammunition Shipments
Military Ocean Terminal, Sunny Point
Jan - Mar (Inclusive) 1970

Item	Tonnage (S/T)	Percent of Total
Aircraft flare	1,005	.30
Flare	1,776	.54
Projectile, 155-mm	48,185	14.73
Charge, 155-mm	20,084	6.14
Projectile, 8-in.	14,567	4.45
Charge, 8-in.	2,551	.78
Projectile, 175-mm	7,547	2.30
Charge, 175-mm	7,007	2.14
Cartridge, 105-mm	77,102	23.76
Projectile, 76-mm	53	.01
Cartridge, 152-mm	805	.24
Rocket, 3.5-in.	2,477	.75
Projectile, 5-in.	437	.13
Charge, 5-in.	222	.06
Cartridge, 165-mm	145	.04
Grenades	3,902	1.19
Small arms	12,890	3.94
Mortar, 81-mm	9,985	3.05
Mortar, 4.2-in.	6,247	1.91
Mines, ap	1,356	.41
Cartridge, 106-mm	251	.07
Demolitions	9,250	.82
Cartridge, 20-mm	1,162	.35
Cartridge, 60-mm	2,035	.62
Cartridge, 66-mm	475	.14
Cartridge, 75-mm	330	.10
Cartridge, 90-mm	250	.07
Cartridge, 57-mm	100	.03
Cartridge, 40-mm	558	.17
Bomb, 750-lb	23,667	7.23
Bomb, 500-lb	48,739	14.89
Bomb, 2,000-lb	281	.08
Fuze	9,934	3.03
Cluster Bomblets	51	.01
Riot Gas	581	.17
Rocket, 2.75-in.	10,971	3.35
Total	326,978 S/T	

AMMUNITION DATA

(Item 1)

ITEM Fuzes, N-277 SERVICE Army

PALLET DIMENSIONS (INCHES) 48 x 40.25 x 38.125 PALLET WEIGHT (POUNDS) 1864

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.15	1.94	4	2	B	49.7%	49.0% (C)
8'x8'x20' ASA Standard	1.46	1.94	16	2	A	73.8%	65.4% (C)
a. WTR	1.46	1.94	16	2	A	75.7%	66.4% (C)
b. WTR/SD	1.49	1.94	16	2	A	77.7%	67.5% (C)
c. WTR/DS	1.49	1.94	16	2	A	78.7%	67.5% (C)
d. WTR/C	1.46	1.94	16	2	A	75.7%	66.4% (C)
8'x8-1/2'x20'	1.46	1.94	16	2	A	73.9%	59.2% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 66 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 4)

ITEM Cartridge, 60 mm SERVICE Army

PALLET DIMENSIONS (INCHES) 52.5 x 40 x 40.5 PALLET WEIGHT (POUNDS) 2158

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.34	2.05	4	2	B	57.5%	56.9% (C)
8'x8'x20' ASA Standard	.85	1.03	8	1	A	42.7%	38.0% (C)
a. WTR	.85	1.03	8	1	A	43.8%	38.6% (C)
b. WTR/SD	.86	1.03	8	1	A	45.0%	39.2% (C)
c. WTR/DS	.86	1.03	8	1	A	45.6%	39.2% (C)
d. WTR/C	.85	1.03	8	1	A	43.8%	38.6% (C)
8'x8-1/2'x20'	1.69	2.06	16	2	A	85.5%	68.7% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 5)

ITEM Cartridge, 40 mm SERVICE Army

PALLET DIMENSIONS (INCHES) 48 x 40 x 41.5 PALLET WEIGHT (POUNDS) 1,996

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.62	1.04	2	1	B	26.6%	26.67% (C)
8'x8'x20' ASA Standard	.78	1.04	8	1	A	39.5%	35.6% (C)
a. WTR	.78	1.04	8	1	A	40.5%	36.1% (C)
b. WTR/SD	.80	1.04	8	1	A	41.6%	36.8% (C)
c. WTR/DS	.80	1.04	8	1	A	42.1%	36.7% (C)
d. WTR/C	.78	1.04	8	1	A	40.5%	36.1% (C)
8'x8-1/2'x20'	1.56	2.08	16	2	A	79.0%	64.4% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 10)

ITEM 4.2" Mortar Cartridge SERVICE Army

PALLET DIMENSIONS (INCHES) 45 x 27.125 x 41.25 PALLET WEIGHT (POUNDS) 1440

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.67	1.18	3	1	B	28.8%	25.3% (C)
8'x8'x20' ASA Standard	1.06	1.18	15	1	A	53.5%	42.2% (C)
a. WTR	1.06	1.18	15	1	A	54.8%	42.8% (C)
b. WTR/SD	1.08	1.18	15	1	A	56.3%	43.5% (C)
c. WTR/DS	1.08	1.18	15	1	A	57.0%	43.5% (C)
d. WTR/C	1.06	1.18	15	1	A	54.8%	42.8% (C)
8'x8-1/2'x20'	1.97	2.36	28	2 (P)	A	99.8%	71.2% (W)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 13)

ITEM Charge 155 mm SERVICE Army

PALLET DIMENSIONS (INCHES) 42 x 37 x 45 PALLET WEIGHT (POUNDS) 955

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.30	.61	2	1	A&B	12.7%	23.4% (C)
8'x8'x20' ASA Standard	.56	.61	12	1	B	28.4%	46.9% (C)
a. WTR	.56	.61	12	1	B	29.1%	47.6% (C)
b. WTR/SD	.57	.61	12	1	B	29.8%	48.4% (C)
c. WTR/DS	.57	.61	12	1	B	30.2%	48.4& (C)
d. WTR/C	.56	.61	12	1	B	29.1%	47.6% (C)
8'x8-1/2'x20'	.56	.61	12	1	B	28.4%	42.4% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 14)

ITEM Projectile, 155 mm HOW SERVICE Army

PALLET DIMENSIONS (INCHES) 29 x 20.25 x 31.57 PALLET WEIGHT (POUNDS) 1,290

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	2.20	4.39	11	2 (P)	B	94.6% (W)	34.3%
	2.20	4.39	11	2 (P)	A	94.6% (W)	34.3%
8'x8'x20' ASA Standard.	1.96	2.20	31	1 (P)	A or B	99.0% (W)	32.3%
a. WTR	1.90	2.20	30	1 (P)	A or B	98.2% (W)	31.7%
b. WTR/SD	1.86	2.20	29	1 (P)	A or B	97.4% (W)	31.2%
	1.86	2.20	29	1 (P)	A	98.7% (W)	31.2%
c. WTR/DS	1.86	4.39	29	2 (P)	B	98.7% (W)	31.2%
d. WTR/C	1.90	2.20	30	1 (P)	A or B	98.2% (W)	31.7%
8'x8-1/2'x20'	2.0	2.20	31	1 (P)	A or B	99.0% (W)	29.2%
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 — Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. — DATA SHEET — 1685-70

AMMUNITION DATA

(Item 15)

ITEM Projectile, 8"   SERVICE Army

PALLET DIMENSIONS (INCHES) 25.5 x 9.5 x 38.5   PALLET WEIGHT (POUNDS) 633

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	2.25	5.23	23	(Top Tier 5) 2 (P)	B	97.0% (W)	35.9%
	2.25	5.23	23	(Top Tier 2) 2 (P)	A	97.0% (W)	35.9%
8'x8'x20' ASA Standard	1.95	2.61	63	1 (P)	A or B	98.7% (W)	32.8%
a. WTR	1.92	2.61	62	1 (P)	A or B	99.6% (W)	32.8%
b. WTR/SD	1.89	2.61	60	1 (P)	A or B	98.9% (W)	32.3%
c. WTR/DS	1.86	2.61	59	1 (P)	A or B	98.5% (W)	31.7%
d. WTR/C	1.92	2.61	62	1 (P)	A or B	99.6% (W)	32.8%
8'x8-1/2'x20'	1.95	2.61	63	1 (P)	A or B	98.7% (W)	29.7%
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C   Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted.   DATA SHEET   1685-70

AMMUNITION DATA

(Item 17)

ITEM Cartridge, 50 cal SERVICE Army

PALLET DIMENSIONS (INCHES) 48 x 40 x 35 PALLET WEIGHT (POUNDS) 2,000

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.24	2.08	4	2	B	53.3%	45.0% (C)
8'x8'x20' ASA Standard	1.57	2.08	16	2	A	79.2%	60.1% (C)
a. WTR	1.57	2.08	16	2	A	81.2%	61.0% (C)
b. WTR/SD	1.59	2.08	16	2	A	83.3%	62.0% (C)
c. WTR/DS	1.59	2.08	16	2	A	84.4%	62.0% (C)
d. WTR/C	1.57	2.08	16	2	A	81.2%	61.)% (C)
8'x8-1/2'x20'	1.57	2.08	16	2	A	79.2%	54.3% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 19)

ITEM Cartridge, 5.56 mm SERVICE Army

PALLET DIMENSIONS (INCHES) 48 x 40.625 x 34.75 PALLET WEIGHT (POUNDS) 2,020

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.25	2.07	4	2	B	53.9%	45.4% (C)
8'x8'x20' ASA Standard	1.58	2.07	16	2	A	80.0%	60.6% (C)
a. WTR	1.58	2.07	16	2	A	82.0%	61.5% (C)
b. WTR/SD	1.61	2.07	16	2	A	84.2%	62.5% (C)
c. WTR/DS	1.61	2.07	16	2	A	85.3%	62.5% (C)
d. WTR/C	1.58	2.07	16	2	A	82.0%	61.5% (C)
8'x8-1/2'x20'	1.58	2.07	16	2	A	80.0%	54.8% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 21)

ITEM Rocket 2.75 whd SERVICE Army

PALLET DIMENSIONS (INCHES) 49.5 x 41.625 x 32.75 PALLET WEIGHT (POUNDS) 2,224

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.38	2.16	4	2	B	59.3%	45.2% (C)
8'x8'x20' ASA Standard	1.74	2.16	16	2	A	88.1%	60.3% (C)
a. WTR	1.74	2.16	16	2	A	90.3%	61.2% (C)
b. WTR/SD	1.77	2.16	16	2	A	92.7%	62.3% (C)
c. WTR/DS	1.77	2.16	16	2	A	93.7%	62.3% (C)
d. WTR/C	1.74	2.16	16	2	A	90.3%	61.2% (C)
8'x8-1/2'x20'	1.74	2.16	16	2	A	88.1%	54.5% (C)
8'x4'x20	-	-	TOO -	HIGH -	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 23)

ITEM Grenade SERVICE Army

PALLET DIMENSIONS (INCHES) 48 x 40.125 x 42.25 PALLET WEIGHT (POUNDS) 1,648

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.51	.86	2	1	B	22.0%	27.2% (C)
8'x8'x20' ASA Standard	.65	.86	8	1	A	32.6%	36.4% (C)
a. WTR	.65	.86	8	1	A	33.5%	36.9% (C)
b. WTR/SD	.66	.86	8	1	A	34.3%	37.5% (C)
c. WTR/DS	.66	.86	8	1	A	34.8%	37.5% (C)
d. WTR/C	.65	.86	8	1	A	33.5%	36.9% (C)
8'x8-1/2'x20'	1.29	1.71	16	2	A	65.3%	65.8% (C)
8'x4'x20	-	-	TOO -	HIGH -	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 25)

ITEM Cartridge, 81 mm SERVICE Army

PALLET DIMENSIONS (INCHES) 53.75 x 42 x 45.25 PALLET WEIGHT (POUNDS) 2,008

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.62	.89	2	1	B	26.7%	34.2% (C)
8'x8'x20' ASA Standard	.79	.89	8	1	A	39.8%	45.7% (C)
a. WTR	.79	.89	8	1	A	40.8%	46.3% (C)
b. WTR/SD	.80	.89	8	1	A	41.8%	47.1% (C)
c. WTR/DS	.80	.89	8	1	A	42.4%	47.1% (C)
d. WTR/C	.79	.89	8	1	A	40.8%	46.3% (C)
8'x8-1/2'x20'	.79	.89	8	1	A	39.8%	41.3% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA
(Item 27)

ITEM Cartridge, 7.62 mm SERVICE Army

PALLET DIMENSIONS (INCHES) 52.125 x 40.625 x 28.5 PALLET WEIGHT (POUNDS) 1,870

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.16	1.77	4	2	B	49.9%	40.4% (C)
8'x8'x20' ASA Standard	1.47	1.77	16	2	A	74.1%	53.9% (C)
a. WTR	1.47	1.77	16	2	A	75.9%	54.7% (C)
b. WTR/SD	1.49	1.77	16	2	A	77.9%	55.7% (C)
c. WTR/DS	1.49	1.77	16	2	A	78.9%	55.7% (C)
d. WTR/C	1.47	1.77	16	2	A	75.9%	54.7% (C)
8'x8-1/2'x20'	1.92	2.65	21	3 (P)	A	97.2%	64.0% (C)
8'x4'x20	.73	.88	8	1	A	37.0%	62.0% (C)

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C   Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted.   DATA SHEET   1685-70

AMMUNITION DATA

(Item 28)

ITEM Cartridge, 152 mm SERVICE Army

PALLET DIMENSIONS (INCHES) 41.875 x 38.0625 x 46.8625 PALLET WEIGHT (POUNDS) 918

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.28	.58	2	1	A or B	12.2%	24.9% (C)
8'x8'x20' ASA Standard	.54	.58	12	1	B	27.3%	50.0% (C)
a. WTR	.54	.58	12	1	B	28.0%	50.8% (C)
b. WTR/SD	.55	.58	12	1	B	28.7%	51.6% (C)
c. WTR/DS	.55	.58	12	1	B	29.1%	51.6% (C)
d. WTR/C	.54	.58	12	1	B	28.0%	50.8% (C)
8'x8-1/2'x20'	.54	.58	12	1	B	27.3%	45.2% (C)
8'x4'x20		-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 32)

ITEM Projectile, 175 mm SERVICE Army

PALLET DIMENSIONS (INCHES) 25.75 x 17.125 x 41 PALLET WEIGHT (POUNDS) 948

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	2.20	4.30	15	2 (P)	A	94.8% (W)	45.4%
	2.20	4.30	15	2 (P)	B	94.8% (W)	45.4%
8'x8'x20' ASA Standard	1.95	2.15	42	1 (P)	A	98.6% (W)	42.4%
a. WTR	1.90	2.15	41	1 (P)	A	98.6% (W)	42.0%
b. WTR/SD	1.89	2.15	40	1 (P)	A	98.8% (W)	41.7%
c. WTR/DS	1.84	2.15	39	1 (P)	A	97.6% (W)	40.7%
d. WTR/C	1.90	2.15	41	1 (P)	A	98.6% (W)	42.0%
8'x8-1/2'x20'	1.95	2.15	42	1 (P)	A	98.6% (W)	38.4%
	1.95	2.15	42	2 (P)	B	98.6% (W)	38.4%
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 33)

ITEM Flares Surface SERVICE Army

PALLET DIMENSIONS (INCHES) 39.75 x 36.125 x 50 PALLET WEIGHT (POUNDS) 1,559

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.48	1.09	2	1	A or B	20.8%	24.0% (C)
8'x8'x20' ASA Standard	.92	1.09	12	1	B	46.3%	48.1% (C)
a. WTR	.92	1.09	12	1	B	47.5%	48.8% (C)
b. WTR/SD	.93	1.09	12	1	B	48.7%	49.7% (C)
c. WTR/DS	.93	1.09	12	1	B	49.4%	49.7% (C)
d. WTR/C	.92	1.09	12	1	B	47.5%	48.8% (C)
8'x8-1/2'x20'	.92	1.09	12	1	B	46.3%	44.0% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 35)

ITEM 175 mm Charge SERVICE Army

PALLET DIMENSIONS (INCHES) 55 x 40 x 45.5 PALLET WEIGHT (POUNDS) 2,001

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.62	.91	2	1	B	26.7%	33.5% (C)
8'x8'x20' ASA Standard	.78	.91	8	1	8	39.6%	44.7% (C)
a. WTR	.78	.91	8	1	A	40.6%	45.4% (C)
b. WTR/SD	.80	.91	8	1	B	41.7%	46.2% (C)
c. WTR/DS	.80	.91	8	1	A	42.2%	46.2% (C)
d. WTR/C	.62	.91	8	1	B	39.6%	44.7% (C)
8'x8-1/2'x20'	.78	.91	8	1	B	39.6%	40.5% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA
(Item 36)

ITEM 8 in. Charge SERVICE ARMY

PALLET DIMENSIONS (INCHES) 55.5x43.25x49.25 PALLET WEIGHT (POUNDS) 2,146

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.66	.89	2	1	B	28.6%	39.6% (C)
8'x8'x20' ASA Standard	.84	.89	8	1	B	42.5%	52.8% (C)
a. WTR	.84	.89	8	1	A	43.6%	53.6% (C)
b. WTR/SD	.86	.89	8	1	B	44.7%	54.5% (C)
c. WTR/DS	.86	.89	8	1	A	45.3%	54.5% (C)
d. WTR/C	.84	.89	8	1	B	42.5%	52.8% (C)
8'x8-1/2'x20'	.84	.89	8	1	B	42.5%	47.8% (C)
8'x4'x20	-	-	Too - high	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 37)

ITEM Mine (AP) SERVICE ARMY

PALLET DIMENSIONS (INCHES) 48x42.25x48.25 PALLET WEIGHT (POUNDS) 2,008

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.62	.99	2	1	B	26.8%	32.8% (C)
8'x8'x20' ASA Standard	.79	.99	8	1	B	39.8%	43.7% (C)
a. WTR	.79	.99	8	1	A	40.8%	44.4% (C)
b. WTR/SD	.80	.99	8	1	B	41.8%	45.1% (C)
c. WTR/DS	.80	.99	8	1	A	42.4%	45.1% (C)
d. WTR/C	.79	.99	8	1	B	39.8%	43.7% (C)
8'x8-1/2'x20'	.79	.99	8	1	B	39.8%	39.5% (C)
8'x4'x20	-	-	Too - high	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 38)

ITEM 105 mm. Projectile SERVICE ARMY

PALLET DIMENSIONS (INCHES) 37.5x36.375x43.75 PALLET WEIGHT (POUNDS) 1,825

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.56	1.34	2	1	A/B	24.3%	20.0% (C)
8'x8'x20' ASA Standard	1.07	1.34	12	1	A/B	54.2%	40.0% (C)
a. WTR	1.07	1.34	12	1	A/B	55.6%	40.6% (C)
b. WTR/SD	1.09	1.34	12	1	A/B	57.0%	41.3% (C)
c. WTR/DS	1.09	1.34	12	1	A/B	57.8%	41.3% (C)
d. WTR/C	1.07	1.34	12	1	A/B	55.6%	40.6% (C)
8'x8-1/2'x20'	1.97	2.68	22	2 (P)	A/B	99.4% (W)	66.3% (C)
8'x4'x20	-	-	Too - high	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 1)

ITEM Cartridge, 50 cal SERVICE Navy

PALLET DIMENSIONS (INCHES) 47.5 x 37 x 34.875 PALLET WEIGHT (POUNDS) 2,730

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.69	3.11	4	2	B	72.8%	41.0% (C)
8'x8'x20' ASA Standard	1.87	3.11	14	2 (P)	A	94.6% (W)	47.9%
a. WTR	1.87	3.11	14	2 (P)	A	97.0% (W)	48.7%
b. WTR/SD	1.90	3.11	14	2 (P)	A	99.5% (W)	49.5%
c. WTR/DS	1.77	3.11	13	2 (P)	A	93.6% (W)	45.9%
d. WTR/C	1.87	3.11	14	2 (P)	A	97.0% (W)	48.7%
8'x8-1/2'x20'	1.87	3.11	14	2 (P)	A	94.6% (W)	43.3%
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 2)

ITEM Cartridge, 20 mm SERVICE Navy

PALLET DIMENSIONS (INCHES) 47.5 x 37 x 34.875 PALLET WEIGHT (POUNDS) 2,810

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.74	3.20	4	2	B	74.9%	41.0% (C)
8'x8'x20' ASA Standard	1.93	3.20	14	2 (P)	A	97.4% (W)	47.9%
a. WTR	1.93	3.20	14	2 (P)	A	99.8% (W)	48.7%
b. WTR/SD	1.82	3.20	13	2 (P)	A	95.1% (W)	45.9%
c. WTR/DS	1.82	3.20	13	2 (P)	A	96.4% (W)	45.9%
d. WTR/C	1.93	3.20	14	2 (P)	A	99.8% (W)	48.7%
8'x8-1/2'x20'	1.93	3.20	14	2 (P)	A	97.4% (W)	43.3%
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 3)

ITEM 250 lb Bomb, G.P. SERVICE Navy

PALLET DIMENSIONS (INCHES) 48.8125 x 40.75 x 34.25 PALLET WEIGHT (POUNDS) 2,266

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.40	2.28	4	2	B	60.4%	45.6% (C)
8'x8'x20' ASA Standard	1.78	2.28	16	2	A	89.7%	60.9% (C)
a. WTR	1.78	2.28	16	2	A	92.0%	61.8% (C)
b. WTR/SD	1.81	2.28	16	2	A	94.4% (W)	62.8%
c. WTR/DS	1.81	2.28	16	2	A	95.7% (W)	62.8%
d. WTR/C	1.78	2.28	16	2	A	92.0%	61.8% (C)
8'x8-1/2'x20'	1.78	2.28	16	2	A	89.7%	55.1% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 4)

ITEM Fuze, Bomb (M-128 etc.) SERVICE Navy

PALLET DIMENSIONS (INCHES) 49.25 x 41.25 x 42 PALLET WEIGHT (POUNDS) 1,630

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.50	.80	2	1	B	21.7%	28.5% (C)
8'x8'x20' ASA Standard	.64	.80	8	1	A	32.2%	38.1% (C)
a. WTR	.64	.80	8	1	A	33.0%	38.7% (C)
b. WTR/SD	.65	.80	8	1	A	34.0%	39.4% (C)
c. WTR/DS	.65	.80	8	1	A	34.4%	39.4% (C)
d. WTR/C	.64	.80	8	1	A	33.0%	38.7%
8'x8-1/2'x20'	1.28	1.60	16	2	A	64.6%	69.0% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

AMMUNITION DATA

(Item 5)

ITEM 500 lb Bomb, G.P. SERVICE Navy

PALLET DIMENSIONS (INCHES) 50.75 x 45.5 x 38.875 PALLET WEIGHT (POUNDS) 3,264

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.01	2.83	2	2	A or B	43.5%	30.0% (C)
8'x8'x20' ASA Standard	1.60	2.83	10	2	B	80.8%	50.1% (C)
a. WTR	1.60	2.83	10	2	B	82.8%	50.9% (C)
b. WTR/SD	1.63	2.83	10	2	B	85.0%	51.8% (C)
c. WTR/DS	1.63	2.83	10	2	B	86.1%	51.8% (C)
d. WTR/C	1.60	2.83	10	2	B	82.8%	50.9% (C)
8'x8-1/2'x20'	1.60	2.83	10	2	B	80.8%	45.3% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 6)

ITEM Demo, Kit, Bangalore Torpedo, M1A1 SERVICE Navy

PALLET DIMENSIONS (INCHES) 63.4375 x 46.3125 x 26.5 PALLET WEIGHT (POUNDS) 2,110

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.98	2.15	3	3	A or B	42.2%	39.1% (C)
8'x8'x20' ASA Standard	1.03	1.44	10	2	8	52.2%	43.5% (C)
a. WTR	1.03	1.44	10	2	8	53.6%	44.2% (C)
b. WTR/SD	1.05	1.44	10	2	B	54.9%	44.9% (C)
c. WTR/DS	1.05	1.44	10	2	B	55.7%	44.9% (C)
d. WTR/C	1.03	1.44	10	2	B	53.6%	44.2% (C)
8'x8-1/2'x20'	1.55	2.15	15	3	B	78.3%	59.0% (C)
8'x4'x20	.52	.72	5	1	B	26.1%	49.9% (C)

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 7)

ITEM Warhead, 5" Rocket SERVICE Navy

PALLET DIMENSIONS (INCHES) 48.5 x 41.75 x 40.75 PALLET WEIGHT (POUNDS) 2544

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.57	2.51	4	2	B	67.8%	55.2% (C)
8'x8'x20' ASA Standard	1.00	1.26	8	1	A	50.4%	36.9% (C)
a. WTR	1.00	1.26	8	1	A	51.7%	37.4% (C)
b. WTR/SD	1.01	1.26	8	1	A	53.0%	38.1% (C)
c. WTR/DS	1.01	1.26	8	1	A	53.7%	38.1% (C)
d. WTR/C	1.00	1.26	8	1	A	51.7%	37.4% (C)
8'x8-1/2'x20'	1.87	2.51	15	2 (P)	A	94.5% (W)	62.5%
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item B)

ITEM 1,000 lb Low Drag Bomb, G.P. MK83 SERVICE Navy

PALLET DIMENSIONS (INCHES) 74.375 x 44.25 x 23.5 PALLET WEIGHT (POUNDS) 2900

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.35	2.64	3	3	A	58.0%	38.8% (C)
8'x8'x20' ASA Standard	1.85	2.64	13	3 (P)	B	93.3% (W)	56.2%
a. WTR	1.85	2.64	13	3 (P)	B	95.7% (W)	57.0%
b. WTR/SD	1.88	2.64	13	3 (P)	B	98.2% (W)	58.0%
c. WTR/DS	1.88	2.64	13	3 (P)	B	99.5% (W)	58.0%
d. WTR/C	1.85	2.64	13	3 (P)	B	95.7% (W)	57.0%
8'x8-1/2'x20'	1.85	2.64	13	3 (P)	B	93.3% (W)	50.8%
8'x4'x20	.71	.88	5	1	B	35.8%	49.6% (C)

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

AMMUNITION DATA

(Item 10)

ITEM Fins, Bomb M131A1 (for 750 lb Demo Bomb) SERVICE Navy

PALLET DIMENSIONS (INCHES) 50.625 x 40.125 x 40 PALLET WEIGHT (POUNDS) 585

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.36	.58	4	2	8	15.6%	54.4% (C)
8'x8'x20' ASA Standard	.23	.29	8	1	A	11.6%	36.3% (C)
a. WTR	.23	.29	8	1	A	11.9%	36.9% (C)
b. WTR/SD	.23	.29	8	1	A	12.2%	37.5% (C)
c. WTR/DS	.23	.29	8	1	A	12.3%	37.5% (C)
d. WTR/C	.23	.29	8	1	A	11.9%	36.9% (C)
8'x8-1/2'x20'	.46	.58	16	2	A	23.2%	65.7% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 11)

ITEM Mine, Underwater, MK55 SERVICE Navy

PALLET DIMENSIONS (INCHES) 84 x 28.75 x 32.5 PALLET WEIGHT (POUNDS) 2221

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.37	1.84	4	2	A	59.2%	52.5% (C)
8'x8'x20' ASA Standard	1.74	1.84	16	2	B	88.0%	70.2% (C)
a. WTR	1.74	1.84	16	2	B	90.2%	71.2% (C)
b. WTR/SD	1.77	1.84	16	2	B	92.5%	72.4% (C)
c. WTR/DS	1.77	1.84	16	2	B	93.8%	72.4% (C)
d. WTR/C	1.74	1.84	16	2	B	90.2%	71.2% (C)
8'x8-1/2'x20'	1.74	1.84	16	2	B	88.0%	63.4% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 12)

ITEM Smokeless Powder, Cannon SERVICE Navy

PALLET DIMENSIONS (INCHES) 56.75 x 40 x 37.25 PALLET WEIGHT (POUNDS) 2558

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.58	2.25	4	2	B	68.2%	56.6% (C)
8'x8'x20' ASA Standard	1.88	2.25	15	2 (P)	A	95.0% (W)	70.9%
a. WTR	1.88	2.25	15	2 (P)	A	97.4% (W)	71.9%
b. WTR/SD	1.91	2.25	15	2 (P)	A	99.9% (W)	73.1%
c. WTR/DS	1.78	2.25	14	2 (P)	A	94.5% (W)	68.3%
d. WTR/C	1.88	2.25	15	2 (P)	A	97.4% (W)	71.9%
8'x8-1/2'x20'	1.88	2.25	15	2 (P)	A	95.0% (W)	64.1%
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 13)

ITEM Charge, Demo, Shaped, MK45 SERVICE Navy

PALLET DIMENSIONS (INCHES) 50.125 x 43.3125 x 45.375 PALLET WEIGHT (POUNDS) 1930

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.60	.89	2	1	B	25.7%	33.0% (C)
8'x8'x20' ASA Standard	.76	.89	8	1	A	38.2%	44.0% (C)
a. WTR	.76	.89	8	1	A	39.2%	44.7% (C)
b. WTR/SD	.48	.89	5	1	B	25.1%	28.4% (C)
c. WTR/DS	.48	.89	5	1	B	25.5%	28.4% (C)
d. WTR/C	.76	.89	8	1	A	39.2%	44.7% (C)
8'x8-1/2'x20'	.75	.89	8	1	A	38.2%	39.8% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 14)

ITEM Cartridge 5"/54 SERVICE Navy

PALLET DIMENSIONS (INCHES) 49 x 36.375 x 51.875 PALLET WEIGHT (POUNDS) 1943

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.60	1.09	2	1	B	25.9%	31.0% (C)
8'x8'x20' ASA Standard	.76	1.09	8	1	A	38.5%	41.3% (C)
a. WTR	.76	1.09	8	1	A	39.5%	41.9% (C)
b. WTR/SD	.77	1.09	8	1	A	40.5%	42.6% (C)
c. WTR/DS	.77	1.09	8	1	A	41.0%	42.6% (C)
d. WTR/C	.76	1.09	8	1	A	39.5%	41.9% (C)
8'x8-1/2'x20'	.76	1.09	8	1	A	38.5%	37.4% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 15)

ITEM Projectile, 5"/54 SERVICE Navy

PALLET DIMENSIONS (INCHES) 48 x 40 x 31.75 PALLET WEIGHT (POUNDS) 3610

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	2.23	3.76	4	2	B	96.3% (W)	40.8%
8'x8'x20' ASA Standard	1.95	3.76	11	2 (P)	A	98.3% (W)	37.4%
a. WTR	1.77	3.76	10	2 (P)	A	91.6% (W)	34.6%
b. WTR/SD	1.80	3.76	10	2 (P)	A	94.0% (W)	35.1%
c. WTR/DS	1.80	3.76	10	2 (P)	A	95.3% (W)	35.1%
d. WTR/C	1.77	3.76	10	2 (P)	A	91.6% (W)	34.6%
8'x8-1/2'x20'	1.95	3.76	11	2 (P)	A	98.3% (W)	33.9%
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 16)

ITEM Cartridge 8"/55 SERVICE Navy

PALLET DIMENSIONS (INCHES) 54.625 x 42.125 x 45.625 PALLET WEIGHT (POUNDS) 1553

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.48	.67	2	1	8	20.7%	35.1% (C)
8'x8'x20' ASA Standard	.61	.67	8	1	A	30.8%	46.9% (C)
a. WTR	.61	.67	8	1	A	31.5%	47.6% (C)
b. WTR/SD	.62	.67	8	1	A	32.4%	48.4% (C)
c. WTR/DS	.62	.67	8	1	A	32.8%	48.4% (C)
d. WTR/C	.61	.67	8	1	A	31.5%	47.6% (C)
8'x8-1/2'x20'	.61	.67	8	1	A	30.8%	42.4% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

AMMUNITION DATA

(Item 17)

ITEM Projectile, 8" AP MK21 SERVICE Navy

PALLET DIMENSIONS (INCHES) 48.125 x 40 x 16 PALLET WEIGHT (POUNDS) 1867

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	2.31	3.88	8	4	B	99.6% (W)	41.2%
8'x8'x20' ASA Standard	1.92	2.91	21	3 (P)	A	97.0% (W)	36.1%
a. WTR	1.92	2.91	21	3 (P)	A	99.5% (W)	36.7%
b. WTR/SD	1.86	2.91	20	3 (P)	A	97.2% (W)	35.5%
c. WTR/DS	1.86	2.91	20	3 (P)	A	98.5% (W)	35.5%
d. WTR/C	1.92	2.91	21	3 (P)	A	99.5% (W)	36.7%
8'x8-1/2'x20'	1.92	2.91	21	3 (P)	A	97.0% (W)	32.7%
8'x4'x20	.73	.97	8	1	A	37.0%	31.6% (C)

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 18)

ITEM Charge, Propelling, M67 SERVICE Navy

PALLET DIMENSIONS (INCHES) 52.5 x 40 x 32 PALLET WEIGHT (POUNDS) 767

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.47	.73	4	2	B	20.5%	45.0% (C)
8'x8'x20' ASA Standard	.60	.73	16	2	A	30.4%	60.1% (C)
a. WTR	.60	.73	16	2	A	31.1%	61.0% (C)
b. WTR/SD	.61	.73	16	2	A	32.0%	62.0% (C)
c. WTR/DS	.61	.73	16	2	A	32.4%	62.0% (C)
d. WTR/C	.60	.73	16	2	A	31.1%	61.0% (C)
8'x8-1/2'x20'	.60	.73	16	2	A	30.4%	54.3% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 19)

ITEM 16" A.P. Projectile SERVICE Navy

PALLET DIMENSIONS (INCHES) 72 x 24.5 x 26.5 PALLET WEIGHT (POUNDS) 2792

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	2.16	3.17	5	2 (P)	A	93.1% (W)	39.1%
8'x8'x20' ASA Standard	1.91	3.17	14	2 (P)	A or B	96.8% (W)	36.6%
a. WTR	1.91	3.17	14	2 (P)	A or B	99.2 % (W)	37.10%
b. WTR/SD	1.81	3.17	13	2 (P)	A or B	94.5% (W)	35.0%
c. WTR/DS	1.81	3.17	13	2 (P)	A or B	95.8% (W)	35.0%
d. WTR/C	1.91	3.17	14	2 (P)	A or B	99.2% (W)	37.1%
8'x8-1/2'x20'	1.91	3.17	14	2 (P)	A or B	96.8% (W)	33.1%
8'x4'x20	1.23	1.58	9	1	A or B	62.2%	54.0% (C)

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 20)

ITEM Explosive section MK1 Mod 1 for Mine, MK56 Modo SERVICE Navy

PALLET DIMENSIONS (INCHES) 53.625 x 50 x 31.3125 PALLET WEIGHT (POUNDS) 978

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.30	.73	2	2	A or B	13.0%	28.1% (C)
8'x8'x20' ASA Standard	.38	.73	8	2	A or B	19.4%	37.5% (C)
a. WTR	.38	.73	8	2	A or B	19.9%	38.1% (C)
b. WTR/SD	.39	.73	8	2	A or B	20.4%	38.7% (C)
c. WTR/DS	.39	.73	8	2	A or B	20.6%	38.7% (C)
d. WTR/C	.38	.73	8	2	A or B	19.9%	38.1% (C)
8'x8-1/2'x20'	.38	.73	8	2	A or B	19.4%	33.9% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 1)

ITEM CBU 28/A Dispenser & Bomb SERVICE Air Force

PALLET DIMENSIONS (INCHES) 99.625 x 28 x 28.24 PALLET WEIGHT (POUNDS) 634

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	-	-	TOO - LONG	-	-	-	-
8'x8'x20' ASA Standard	.38	.46	12	2	A	19.1%	52.8% (C)
a. WTR	.38	.46	12	2	A	19.6%	53.6% (C)
b. WTR/SD	.38	.46	12	2	A	20.1%	54.5% (C)
c. WTR/DS	.38	.46	12	2	A	20.4%	54.5% (C)
d. WTR/C	.38	.46	12	2	A	19.6%	53.6% (C)
8'x8-1/2'x20'	.57	.69	18	3	A	28.6%	71.6% (C)
8'x4'x20	.19	.23	6	1	A	9.5%	60.7% (C)

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 2)

ITEM Cartridge, 20 mm Linked   SERVICE Air Force

PALLET DIMENSIONS (INCHES) 20.75 x 9.25 x 17   PALLET WEIGHT (POUNDS) 100

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.73	2.08	112	4	B	74.7%	61.2% (C)
8'x8'x20' ASA Standard	1.96	2.08	400	4	B	99.0%	72.9% (C)
a. WTR	1.93	2.08	394	4 (P)	A or 8	100% (W)	72.9%
b. WTR/SD	1.91	2.08	384	4 (P)	A or B	100% (W)	72.2%
c. WTR/DS	1.89	2.08	379	4 (P)	A or B	100% (W)	71.3%
d. WTR/C	1.93	2.08	394	4 (P)	A or 8	100% (W)	72.9%
8'x8-1/2'x20'	1.98	2.61	404	5 (P)	A or B	100% (W)	66.6%
8'x4'x20	.49	.52	100	1	B	24.8%	41.9% (W)

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C   Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted.   DATA SHEET   1685-70

AMMUNITION DATA

(Item 3)

ITEM Bomb, G.P. M117, 750 lb SERVICE Air Force

PALLET DIMENSIONS (INCHES) 56.25 x 32.25 x 22.75 PALLET WEIGHT (POUNDS) 1,626

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.51	2.69	6	3	A or B	65.0%	41.4% (C)
8'x8'x20' ASA Standard	1.91	2.69	24	3	A	96.6% (W)	55.3%
a. WTR	1.91	2.69	24	3	A	99.0% (W)	56.2%
b. WTR/SD	1.86	2.69	23	3 (P)	A	97.4% (W)	54.7%
c. WTR/DS	1.86	2.69	23	3 (P)	A	98.7% (W)	54.7%
d. WTR/C	1.91	2.69	24	3	A	99.0% (W)	56.2%
8'x8-1/2'x20'	1.91	2.69	24	3	A	96.6% (W)	50.0%
8'x4'x20	.64	.90	8	1	A	32.2%	42.4% (C)

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 4)

ITEM Bomb, G.P. M118, 3,000 lb SERVICE Air Force

PALLET DIMENSIONS (INCHES) 82.75 x 24 x 31.5 PALLET WEIGHT (POUNDS) 3,179

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.97	3.20	4	2 (P)	B	84.8% (W)	41.9%
8'x8'x20' ASA Standard	1.87	3.20	12	2 (P)	A or B	94.4% (W)	41.9%
a. WTR	1.87	3.20	12	2 (P)	A or B	96.8% (W)	42.6%
b. WTR/SD	1.90	3.20	12	2 (P)	A or B	99.3% (W)	43.3%
c. WTR/DS	1.74	3.20	11	2 (P)	A or B	92.3% (W)	49.7%
d. WTR/C	1.87	3.20	12	2 (P)	A or B	96.8% (W)	42.6%
8'x8-1/2'x20'	1.87	3.20	12	2 (P)	A or B	94.4% (W)	37.9%
8'x4'x20	-	-	TOO -	HIGH	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 5)

ITEM Flare MK-45 Mod-0 SERVICE Air Force

PALLET DIMENSIONS (INCHES) 45.5 x 44 x 47.5 PALLET WEIGHT (POUNDS) 1,186

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.37	.59	2	1	A	15.8%	31.8% (C)
8'x8'x20' ASA Standard	.58	.59	10	1	A	29.4%	53.1% (C)
a. WTR	.58	.59	10	1	A	30.1%	53.9% (C)
b. WTR/SD	.30	.59	5	1	A or B	15.4%	27.4% (C)
c. WTR/DS	.30	.59	5	1	A or B	15.6%	27.4% (C)
d. WTR/C	.58	.59	10	1	A	30.1%	53.9% (C)
8'x8-1/2'x20'	.58	.59	10	1	A	29.4%	48.0% (C)
8'x4'x20	-	-	TOO -	HIGH -	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1683-70

AMMUNITION DATA
(Item 6)

ITEM Bomb, G.P. BLU 76/B SERVICE Air Force

PALLET DIMENSIONS (INCHES) 175 x 38 x 45.5 PALLET WEIGHT (POUNDS) 2,217

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	-	-	TOO - LONG	-	-	-	-
8'x8'x20' ASA Standard	.22	.33	2	1	A	11.0%	33.8% (C)
a. WTR	.22	.33	2	1	A	11.3%	34.3% (C)
b. WTR/SD	.22	.33	2	1	A	11.5%	34.9% (C)
c. WTR/DS	.22	.33	2	1	A	11.7%	34.9% (C)
d. WTR/C	.22	.33	2	1	A	11.3%	34.3% (C)
8'x8-1/2'x20'	.22	.33	2	1	A	11.0%	30.6% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 7)

ITEM Bomb, Fire, BLU 27/B SERVICE Air Force

PALLET DIMENSIONS (INCHES) 116.25 x 25.75 x 35.125 PALLET WEIGHT (POUNDS) 990

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	-	-	TOO - LONG	-	-	-	-
8'x8'x20' ASA Standard	.29	.66	6	2	A	14.7%	35.2% (C)
a. WTR	.29	.66	6	2	A	15.1%	35.8% (C)
b. WTR/SD	.30	.66	6	2	A	15.5%	36.4% (C)
c. WTR/DS	.30	.66	6	2	A	15.7%	36.4% (C)
d. WTR/C	.29	.66	6	2	A	15.1%	35.8% (C)
8'x8-1/2'x20'	.29	.66	6	2	A	14.7%	31.9% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 8)

ITEM Bomb, GP 100 lb, AN-M30 SERVICE Air Force

PALLET DIMENSIONS (INCHES) 42 x 38 x 25.25 PALLET WEIGHT (POUNDS) 774

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.72	1.45	6	3	A or B	31.0%	40.5% (C)
8'x8'x20' ASA Standard	1.36	1.45	36	3	B	69.0%	81.0% (C)
a. WTR	1.36	1.45	36	3	B	70.7%	82.3% (C)
b. WTR/SD	1.39	1.45	36	3	B	72.6%	83.6% (C)
c. WTR/DS	1.39	1.45	36	3	B	73.5%	83.6% (C)
d. WTR/C	1.36	1.45	36	3	B	70.7%	82.3% (C)
8'x8-1/2'x20'	1.36	1.45	36	3	B	69.0%	73.3% (C)
8'x4'x20	.45	.48	12	1	B	23.0%	62.1% (C)

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 9)

ITEM Bomb, Demo, BLU 31/B SERVICE Air Force

PALLET DIMENSIONS (INCHES) 70.625 x 40 x 18.5 PALLET WEIGHT (POUNDS) 1,802

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	2.23	2.55	8	4	A	96.1% (W)	70.0%
8'x8'x20' ASA Standard	1.94	2.55	22	4 (P)	A	98.1% (W)	64.2%
a. WTR	1.85	2.55	21	4 (P)	A	96.0% (W)	62.2%
b. WTR/SD	1.89	2.55	21	4 (P)	A	98.5% (W)	63.3%
c. WTR/DS	1.89	2.55	21	4 (P)	A	99.8% (W)	63.3%
d. WTR/C	1.85	2.55	21	4 (P)	A	96.0% (W)	62.2%
8'x8-1/2'x20'	1.94	2.55	22	4 (P)	A	98.1% (W)	58.1%
8'x4'x20	.53	.64	6	1	A	40.2%	53.0% (C)

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 10)

ITEM Bomb 250 lb MK81 SERVICE Air Force

PALLET DIMENSIONS (INCHES) 48 x 40 x 40 PALLET WEIGHT (POUNDS) 3,240

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	2.01	3.38	4	2	A	86.4% (W)	51.4%
8'x8'x20' ASA Standard	1.27	1.69	8	1	A	64.2%	34.3% (C)
a. WTR	1.27	1.69	8	1	A	65.8%	34.8% (C)
b. WTR/SD	1.29	1.69	8	1	A	67.5%	35.4% (C)
c. WTR/DS	1.29	1.69	8	1	A	68.4%	35.4% (C)
d. WTR/C	1.27	1.69	8	1	A	65.8%	34.8% (C)
8'x8-1/2'x20'	1.90	3.38	12	2 (P)	A	96.2% (W)	46.6%
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 11)

ITEM Fin assy MAU 94/B (For MK81 Bomb) SERVICE Air Force

PALLET DIMENSIONS (INCHES) 76.5 x 42.5 x 33 PALLET WEIGHT (POUNDS) 1,067

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.33	.66	2	2	B	14.2%	35.9% (C)
8'x8'x20' ASA Standard	.63	.66	12	2	A	31.7%	71.9% (C)
a. WTR	.63	.66	12	2	A	32.5%	73.0% (C)
b. WTR/SD	.64	.66	12	2	A	33.3%	74.2% (C)
c. WTR/DS	.64	.66	12	2	A	33.8%	74.2% (C)
d. WTR/C	.63	.66	12	2	A	32.5%	73.0% (C)
8'x8-1/2'x20'	.63	.66	12	2	A	31.7%	65.0% (C)
8'x4'x20	-	-	TOO - HIGH	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 12)

ITEM 2.75" Rocket & launcher assy SERVICE Air Force

PALLET DIMENSIONS (INCHES) 61 x 20.25 x 24.5 PALLET WEIGHT (POUNDS) 518

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.96	1.26	12	3	A	41.4%	60.8% (C)
8'x8'x20' ASA Standard	.91	1.26	36	3	A	46.2%	60.9% (C)
a. WTR	.91	1.26	36	3	A	47.3%	61.8% (C)
b. WTR/SD	.93	1.26	36	3	A	48.6%	62.8% (C)
c. WTR/DS	.93	1.26	36	3	A	49.2%	62.8% (C)
d. WTR/C	.91	1.26	36	3	A	47.3%	61.8% (C)
8'x8-1/2'x20'	.91	1.26	36	3	A	46.2%	55.0% (C)
8'x4'x20	.30	.42	12	1	A	15.4%	46.6% (C)

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA
(Item 13)

ITEM Bomb cluster, incendiary (M36E1) SERVICE Air Force

PALLET DIMENSIONS (INCHES) 69 x 32.5 x 23.25 PALLET WEIGHT (POUNDS) 1,906

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.77	2.55	6	3	A or B	76.2%	52.4% (C)
8'x8'x20' ASA Standard	1.96	2.55	21	3	B	99.1% (W)	61.2%
a. WTR	1.87	2.55	20	3 (P)	B	96.8% (W)	59.1%
b. WTR/SD	1.90	2.55	20	3 (P)	B	99.3% (W)	60.1%
c. WTR/DS	1.80	2.55	19	3 (P)	B	95.6% (W)	57.1%
d. WTR/C	1.87	2.55	20	3 (P)	B	96.8% (W)	59.1%
8'x8-1/2'x20'	1.96	2.55	21	3	B	99.1% (W)	55.3%
8'x4'x20	.65	.85	7	1	B	33.0%	46.8% (C)

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 14)

ITEM Bomb, 500 lb., AN-M64 SERVICE Air Force

PALLET DIMENSIONS (INCHES) 61.75x32.5x31.5 PALLET WEIGHT (POUNDS) 3,096

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	1.92	3.09	4	2	A or B	82.6% (W)	42.3%
8'x8'x20' ASA Standard	1.97	3.09	13	2 (P)	B	99.6% (W)	45.9%
a. WTR	1.82	3.09	12	2	A or B	94.3% (W)	43.0%
b. WTR/SD	1.85	3.09	12	2	A	96.8% (W)	43.7%
c. WTR/DS	1.85	3.09	12	2	A	98.0% (W)	43.7%
d. WTR/C	1.82	3.09	12	2	A or B	94.3% (W)	43.0%
8'x8-1/2'x20'	1.97	3.09	13	2 (P)	B	99.6% (W)	41.5%
8'x4'x20	-	-	Too - High	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 15)

ITEM Bomb, G.P., 2,000 lb., AN-M66 A2 SERVICE Air Force

PALLET DIMENSIONS (INCHES) 75x31.5x23.5 PALLET WEIGHT (POUNDS) 2,159

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	2.00	2.74	6	3	B	86.4% (W)	55.8%
8'x8'x20' ASA Standard	1.90	2.74	18	3	A	96.2% (W)	55.8%
a. WTR	1.90	2.74	18	3	A	98.6% (W)	56.7%
b. WTR/SD	1.83	2.74	17	3 (P)	A	95.6% (W)	54.4%
c. WTR/DS	1.83	2.74	17	3 (P)	A	96.8% (W)	54.4%
d. WTR/C	1.90	2.74	18	3	A	98.6% (W)	56.7%
8'x8-1/2'x20'	1.90	2.74	18	3	A	96.2% (W)	50.5%
8'x4'x20	.74	.91	7	1	B	37.4%	49.9% (C)

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 16)

ITEM Bomb, G.P., 1,000 lb., SERVICE Air Force

PALLET DIMENSIONS (INCHES) AN-M44 58x27x29.5 PALLET WEIGHT (POUNDS) 1,050

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.97	1.34	6	2	A	42.0%	46.4% (C)
8'x8'x20' ASA Standard	1.23	1.34	24	2	A	62.4%	61.9% (C)
a. WTR	1.23	1.34	24	2	A	64.0%	62.9% (C)
b. WTR/SD	1.26	1.34	24	2	A	65.6%	63.9% (C)
c. WTR/DS	1.26	1.34	24	2	A	66.5%	63.9% (C)
d. WTR/C	1.23	1.34	24	2	A	64.0%	62.9% (C)
8'x8-1/2'x20'	1.23	1.34	24	2	A	62.4%	56.0% (C)
8'x4'x20	.62	.67	12	1	A	31.2%	71.1% (C)

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 970-C 18 Feb 64 Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

AMMUNITION DATA

(Item 17)

ITEM Flare, Acft, MK 24, Mod-3   SERVICE Air Force

PALLET DIMENSIONS (INCHES) 44x41x47.5   PALLET WEIGHT (POUNDS) 1,048

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.32	.58	2	1	A or B	14.0%	28.7% (C)
8'x8'x20' ASA Standard	.51	.58	10	1	A or B	25.9%	47.9% (C)
a. WTR	.51	.58	10	1	A or B	26.6%	48.6% (C)
b. WTR/SD	.52	.58	10	1	A	27.3%	49.4% (C)
c. WTR/DS	.52	.58	10	1	A	27.7%	49.4% (C)
d. WTR/C	.51	.58	10	1	A or B	26.6%	48.6% (C)
8'x8-1/2'x20'	.51	.58	10	1	A or B	25.9%	43.3% (C)
8'x4'x20	-	-	Too - High	-	-	-	-

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C   Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted.   DATA SHEET   1683-70

AMMUNITION DATA

(Item 18)

ITEM M 904 Fuze, bomb, nose SERVICE Air Force

PALLET DIMENSIONS (INCHES) 24.25x19x13.125 PALLET WEIGHT (POUNDS) 77.5

CONTAINER	AVERAGE LOAD (LB/SQ IN.)	POINT LOAD (LB/SQ IN.)	NUMBER PALLETS	NUMBER TIERS	LOADING METHOD	WEIGHT UTIL	CUBE UTIL
8'x8'x6-2/3' TRICON	.65	1.01	54	6	B	28.0%	54.7% (C)
8'x8'x20' ASA Standard	.82	1.01	216	6	A or B	41.4%	73.0% (C)
a. WTR	.68	.84	180	5	A or B	35.4%	61.7% (C)
b. WTR/SD	.70	.84	180	5	A or B	36.3%	62.8% (C)
c. WTR/DS	.70	.84	180	5	A or B	36.8%	62.8% (C)
d. WTR/C	.68	.84	180	5	A or B	35.4%	61.7% (C)
8'x8-1/2'x20'	.82	1.01	216	6	A or B	41.4%	66.0% (C)
8'x4'x20	.27	.34	72	2	A or B	13.8%	55.9% (C)

LEGEND: WTR - With tiedown rings
SD - Side door
DS - Drop side
C - Cushioned underframe

TCFE FORM 18 Feb 64 970-C Replaces TCFE Form 970-B, 23 Aug 61, which may be used until depleted. DATA SHEET 1685-70

APPENDIX 5 to ANNEX A to Staff Study (Ammunition Container Criteria)
June 1970

Cube Out/Weigh Out Data

Container	Army Cube Out	Army Weigh Out
TRICON 8'x8'x6-2/3'	Cartridge, 105-mm Fuze, N-277 Cartridge, 60-mm Cartridge, 40-mm Cartridge, 4.2-in. Charge, 155-mm Cartridge, 50-cal Cartridge, 5.56-mm Rocket, 2.75-in. Grenade Cartridge, 81-mm Cartridge, 7.62-mm Cartridge, 152-mm Flare, surface Mine, ap Charge, 8-in. Charge, 175-mm	Projectile, 155-mm Projectile, 8-in. Projectile, 175-mm
8'x8'x20'	Cartridge, 105-mm Fuze, N-277 Cartridge, 60-mm Cartridge, 40-mm Cartridge, 4.2-in. Charge, 155-mm Cartridge, 50-cal Cartridge, 5.56-mm Rocket, 2.75-in. Grenade Cartridge, 81-mm Cartridge, 7.62-mm Cartridge, 152-mm Flare, surface Mine, ap Charge, 8-in. Charge, 175-mm	Projectile, 155-mm Projectile, 8-in. Projectile, 175-mm

Cube Out/Weigh Out Data

Container	Army	
	Cube Out	Weigh Out
8'x8-1/2'x20'	Mine, ap Fuze, N-277 Cartridge, 60-mm Cartridge, 40-mm Charge, 155-mm Cartridge, 50-cal Rocket, 2.75-in. Grenade Cartridge, 81-mm Cartridge, 152-mm Flare, surface Cartridge, 5.56-mm Charge, 8-in. Charge, 175-mm	Cartridge, 4.2-in. Projectile, 155-mm Projectile, 8-in. Cartridge, 7.62-mm Projectile, 175-mm
8'x4'x20'	Cartridge, 7.62-mm	

Cube Out/Weigh Out Data

Container	Navy	
	Cube Out	Weigh Out
TRICON 8'x8'x6-2/3'	Cartridge, 50-cal Cartridge, 20-mm Bomb, 250-lb Fuze, bomb Bomb, 500-lb Demolition kit bangalore Warhead, 5-ft rocket Bomb, 1,000-lb Fins, bomb Powder, cannon Mine, underwater Charge, shape Cartridge, 5"/54 Cartridge, 8"/55 Charge, M67 Explosive section-mine	Projectile, 5"/54 Projectile, 8-in. Projectile, 16-in.
8'x8'x20'	Bomb, 250-lb Fuze, bomb Bomb, 500-lb Demolition kit Warhead, 5-in. rocket Fins, bomb Mine, underwater Charge, shape Cartridge, 5"/54 Cartridge, 8"/55 Charge, M67 Explosive section-mine	Cartridge, 50-cal Cartridge, 20-mm Bomb, 1,000-lb Powder, cannon Projectile, 5"/54 Projectile, 8-in. Projectile, 16-in.

Cube Out/Weigh Out Data

Container	Navy: Cube Out	Navy: Weigh Out
8'x8-1/2'x20'	Bomb, 250-lb	Cartridge, 50-cal
	Fuze, bomb	Cartridge, 20-mm
	Bomb, 500-lb	Warhead, 5-in. rocket
	Demolition kit	Bomb, 1,000-lb
	Fins, bomb	Powder, cannon
	Mine, underwater	Projectile, 5"/54
	Charge, shape	Projectile, 8-in.
	Cartridge, 5"/54	Projectile, 16-in.
	Cartridge, 8"/55	
	Charge, M67	
	Explosive section-mine	
8'x4'x20'	Demolition kit	
	Bomb, 1,000-lb	
	Projectile, 8-in.	
	Projectile, 16-in.	

Cube Out/Weigh Out Data

Container	Air Force	
	Cube Out	Weigh Out
TRICON 8'x8'x6-2/3'	Cartridge, 20-mm	Bomb, 3,000-lb
	Bomb, 750-lb	Bomb, demolition blu 31B
	Flare, Mk45	Bomb, 250-lb
	Bomb, blu 76B	Bomb, 500-lb
	Bomb, 100-lb	Bomb, 2,000-lb
	Fin assy, mau 94	
	Rocket launcher assy, 2.75-in.	
	Bomb, cluster assy	
	Bomb, 1,000-lb	
	Flare, Mk24	
	Fuze, M904	
8'x8'x20'	CBU dispenser & bomb	
		Cartridge, 20-mm
	Flare, Mk45	Bomb, 750-lb
	Bomb, blu 76B	Bomb, 3,000-lb
	Bomb, fins	Bomb, demolition blu 31B
	Bomb, 100-lb	Bomb, cluster assy
	Bomb, 250-lb	Bomb, 500-lb
	Fin assy, mau 94	Bomb, 2,000-lb
	Rocket launcher assy, 2.75-in.	
	Bomb, 1,000-lb	
	Flare, Mk24	
	Fuze, M904	

Cube Out/Weigh Out Data

Container		
	Air Force	
	Cube Out	Weigh Out
8'x8-1/2'x20'	CBU dispenser & bomb	Cartridge, 20-mm
	Flare, Mk45	Bomb, 750-lb
	Bomb, blu 76B	Bomb, 3,000-lb
	Bomb, fire	Bomb, demolition blu 31B
	Bomb, 100-lb	Bomb, 250-lb
	Fin assy, mau 94	Bomb, cluster assy
	Rocket launcher assy, 2.75-in.	Bomb, 500-lb
	Bomb, 1,000-lb	Bomb, 2,000-lb
	Flare, Mk24	
	Fuze, M904	
8'x4'x20'	CBU dispenser & bomb	Cartridge, 20-mm
	Bomb, 100-lb	Bomb, 750-lb
	Bomb, demolition blu 31B	
	Rocket launcher assy, 2.75-in.	
	Bomb, cluster assy	
	Bomb, 2,000-lb	
	Bomb, 1,000-lb	
	Fuze, M904	

APPENDIX 6 to ANNEX A to Staff Study (Ammunition Container Criteria)
June 1970

Cube and Weight Utilizations for Pairs of Containers

	Army (percent)		Navy (percent)		Air Force (percent)	
Containers*	Cube	Weight	Cube	Weight	Cube	Weight
6 and 4	52.8	84.9	49.3	67.0	56.1	63.1
6 and 5	52.7	85.3	48.9	66.9	55.8	63.2
6 and 3	52.7	84.7	49.4	66.7	56.1	62.4
6 and 2	52.6	84.3	49.0	65.8	56.0	61.4
6 and 1	51.7	83.2	46.5	64.7	52.3	59.4
7 and 6	50.1	84.4	48.1	61.4	54.9	63.5
5 and 1	43.9	68.4	44.6	61.6	53.4	59.2
4 and 1	43.9	67.8	45.0	61.6	53.5	59.4
3 and 1	43.4	66.8	45.3	61.6	54.2	59.9
5 and 2	43.3	69.5	44.9	62.2	55.3	61.0
4 and 2	43.3	68.9	45.1	62.3	55.3	60.9
5 and 3	43.1	69.4	45.0	62.7	54.9	61.4
4 and 3	43.1	68.8	45.1	62.5	54.9	61.0
7 and 4	43.1	67.9	46.7	57.4	56.2	62.9
7 and 5	43.0	68.6	46.2	57.4	55.9	63.1
5 and 4	43.0	68.6	43.9	61.2	53.2	59.9
2 and 1	42.9	65.9	44.9	60.7	54.3	59.1

*See next page for footnote.

Cube and Weight Utilizations of Pairs of Containers
(contd)

Container*	Army (percent)		Navy (percent)		Air Force (percent)	
	Cube	Weight	Cube	Weight	Cube	Weight
3 and 2	42.7	67.9	44.7	61.8	54.9	60.4
7 and 3	42.7	67.1	47.2	57.5	57.6	63.1
7 and 2	42.4	66.3	46.8	56.8	57.8	62.3
7 and 1	27.7	45.1	32.3	32.0	47.2	40.2

*The containers are coded as follows:

Container 1 - 8'x8'x6-2/3' (TRICON)

Container 2 - 8'x8'x20'

Container 3 - 8'x8'x20' with tiedown rings

Container 4 - 8'x8'x20' with tiedown rings and side door

Container 5 - 8'x8'x20' with tiedown rings and drop side

Container 6 - 8'x8-1/2'x20'

Container 7 - 8'x4'x20'

APPENDIX 7 to ANNEX A to Staff Study (Ammunition Container Criteria)
June 1970

TB 55-100, Transportability Criteria Shock and Vibration, 17 April 1964

TB 55-100

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

TRANSPORTABILITY CRITERIA SHOCK AND VIBRATION

Headquarters, Department of the Army, Washington, D.C.
17 April 1964

1. Purpose. This bulletin sets forth the Department of the Army interim position as regards engineering considerations of shock and vibration environments induced by transportation. It also furnishes basic transportation engineering design parameters for research and development design usage in conjunction with transportability of military items.

2. Scope. The information contained in this bulletin is applicable to all Army cargoes and in particular for rail, air, sea, and highway modes of transport. Shocks and vibrations are illustrated as envelopes of data that inclose maximum accelerations.

3. General. *a.* Increased use of fragile, sensitive, and dangerous items and increased importance of such military items have established an urgent requirement for formal guidance as regards transportation environments. The increasing variety of both military cargoes and transport vehicles with their differing size, mass, and internal cushioning has complicated the process of establishing specific guidelines useable for a broad range of items and carriers.

b. Certain data can be established now in the field of transportation shock and vibration that will be extremely helpful for technical communications and as a tool for analytical comparison. The first step is to obtain and use acceleration inputs to a transportation system that are independent of the operational characteristics, such as the physical state of the right of way, impact speed, sea state, and landing rate. From this point, other factors can be presented that are determined wholly or in part by the mechanical makeup and operational characteristics of the transportation system, and that are peculiar to the specific system.

c. It is recognized that some combination of forces, accelerations, and frequencies that would classify and standardize the required strength of a broad range of cargoes would be a most useful tool. Work to date in this area has been accomplished on selected items. A complete scientific methodology requires a broad background of field studies designed specifically for this purpose. Considerable effort has been expended, and enough studies have been conducted to develop, empirically, certain shock and vibration producing factors, These factors are illustrated and published here to initiate a better interchange and comparison of transportation shock and vibration data; also, to increase utilization of existing data in initially establishing a methodology stated in mathematical and mechanical terminology.

d. The data and guidelines contained in this bulletin comprise the Department of the Army, Chief of Transportation interim position. Transportation Corps efforts will be continuous to keep up with technological advances; the basic factors will be adjusted as required, and additional findings will be included to extend toward the development of a definite analysis procedure.

4. Rail. *a.* The cargo and its restraining systems should be capable of withstanding a transportation shock environment simulated by three successive rail impacts in both car directions of 10-mile-per-hour severity for priority, high value, and sensitive cargoes and 8 miles per hour for general troop support cargoes. The striking (or the car moving before impact) must be either a fully loaded car having a minimum rail load of 169,000 pounds with a standard-travel draft gear, of the car containing the cargo being studied, whichever has the greater weight.

b. The stresses in the restraining members should be less than one-half the yield strength of the material in the static, or restrained condition. The combined static and dynamic stresses must not exceed the static yield strength* of the material in any restraining system component during the dynamic portion of the impact loading. Additional margins of safety may be required during design of the restraining systems because of the cargo's peculiar nature, train safety considerations, or accident effects considerations.

c. For design purposes, the shock environment contained herein should be treated as a definite loading produced by the environment. No safety factors are included in the environmental statements or data.

d. The cargo and its restraining system should be able to withstand without failure or impending failure, a transportation vibration environment equivalent to one produced by over-the-road movement in a 150-car train. The car transporting the cargo should have standard freight car suspension and draft gear, and should be considered for the end of the train car position. Vibrations, both intermittent and continuous, should be of a duration equivalent to the input from 3,000 miles of Class I railroads containing at least 50-percent long maximum grades.

e. Envelopes of the maximum environmental values recorded during Transportation Corps studies for both shock and vibration are shown in figure 1. These values were recorded while using standard commercial rail cars impacted at 10 mph. Data frequencies are limited by the range of response of the recording instrumentation; hence, higher frequency data were filtered before recording.

f. It is recommended that at least six applications of the maximum shock acceleration be applied consistent with three car impacts from each direction. It is recommended that a vibration time be consistent with a 3,000-mile trip, and that design increases for safety be made by increasing the time of vibration rather than by adjusting the amplitude or the frequency.

5. Sea. *a.* For sea transportation, cargo and its restraining system should be capable of sustaining an environment occasioned by a seaway-induced loading on a transport ship consequent to 20 days of Beauford Sea State Condition 12. During this condition, the components of the restraining system should not exhibit a combined static and dynamic stress in excess of 80 percent of the static yield strength* of the materials. The static stresses occasioned by normal tiedown procedures should not exceed 50 percent of the static yield strength* of the materials.

b. Particular emphasis must be placed on the effects of stacking cargo for shipboard transport. Stacking may subject the cargo, the cargo container, or the restraining system to severe loading conditions. As the dynamic and static loads are resisted by each succeeding lower unit of cargo in the stack, the cumulative effect on the bottom units must be considered in design. The same consideration as regards stacking and dynamic loading must be given in the horizontal plane, since longitudinal accelerations will also cause a load buildup on the end unit unless load dividing measures are taken. Effects of cargo stacking are most troublesome in sea transport because of relatively large cargo holds which accommodate excessive stacking.

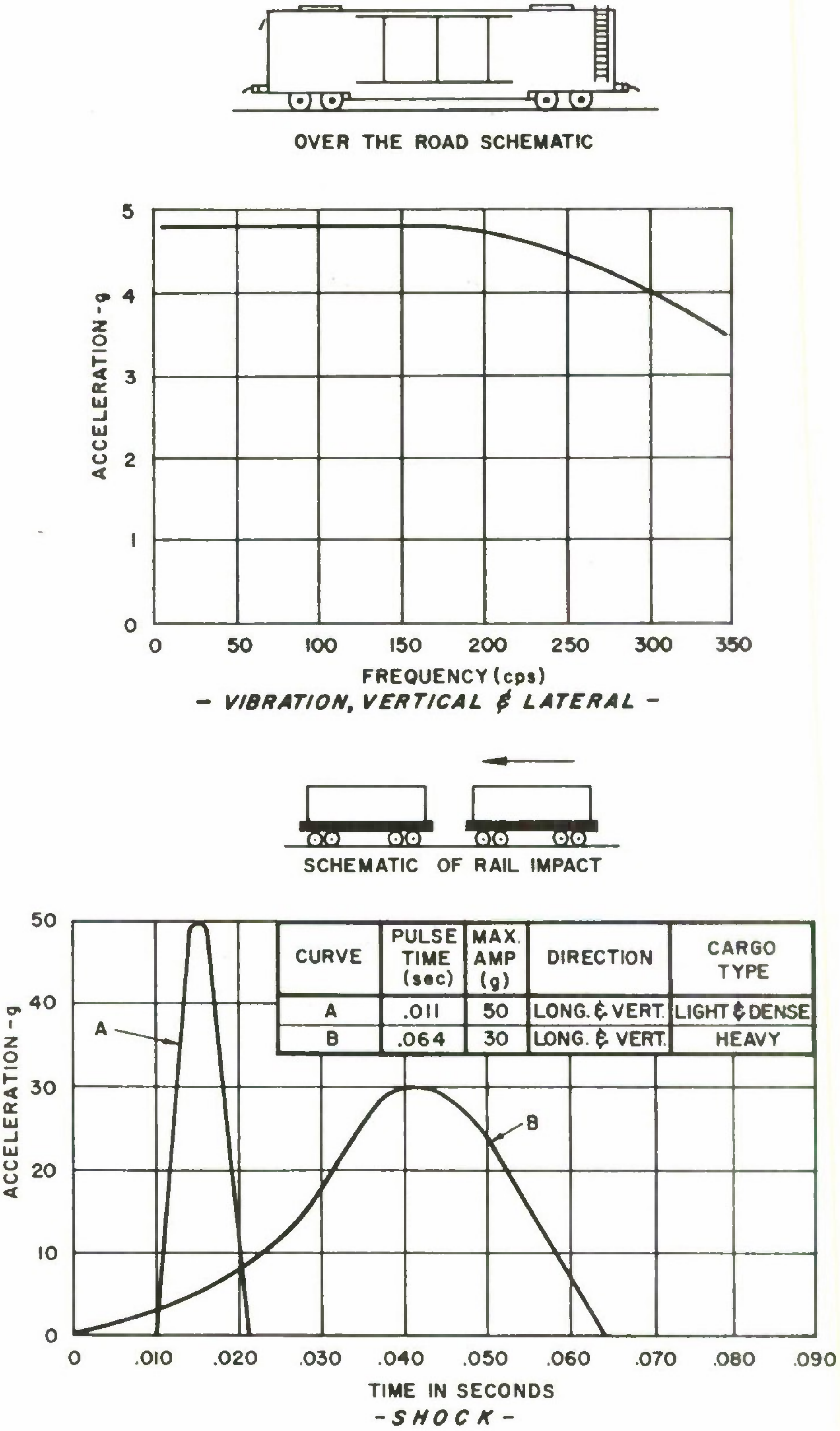
c. Figure 2 presents guidance as to the nature of the sea-induced accelerations on the cargo. The data are a plot of an envelope of the maximum values of the vibrations in the frequency range of 0 to 15 cycles/second. Also shown is a time-history envelope of the maximum shock environment measured.

d. The time recommended for application of the vibration is 20 days. It is recommended that 100 shock applications be considered the minimum requirement.

6. Air. *a.* Induced shock and vibration environments for air transportation are normally considered the least severe as regards loading of the cargo and its restraining system. Factors of plane safety, cost of cargo, and military value of the cargo dictate the highest degree of reliability for the strength of cargo and its restraining systems. Many strength safety factors are employed both in design and operation for restraining systems involving air transport, with consequent multiplication factors applied to the basic environmental data. The basic data should be especially accurate in order to minimize cumulative error on the inaccurate portion of the data that is proportioned or multiplied for safety or design reasons.

b. For air transport, the cargo and its restraining system should be capable of withstanding all the aircraft vibrations occasioned for a time period consistent with the maximum range of the aircraft. It is considered important that the amplitude and

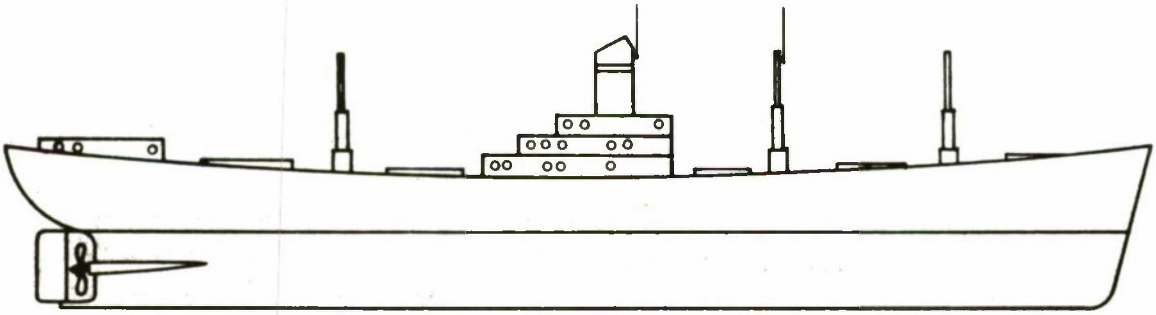
*As published by the American Society for Testing Materials (ASTM).



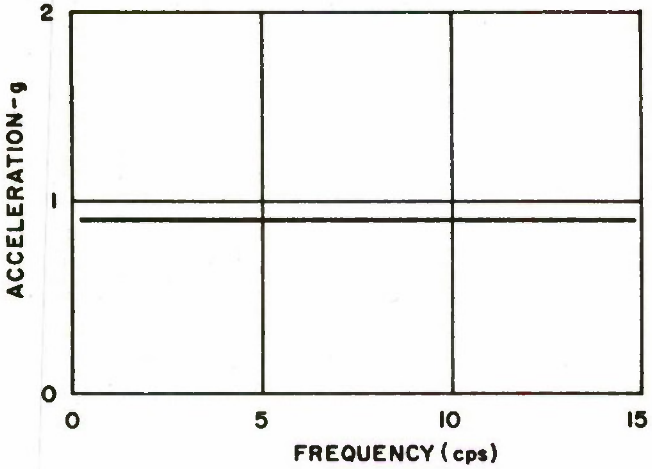
CURVE	PULSE TIME (sec)	MAX. AMP (g)	DIRECTION	CARGO TYPE
A	.011	50	LONG. & VERT.	LIGHT & DENSE
B	.064	30	LONG. & VERT.	HEAVY

CARGO ENVIRONMENTS FOR RAIL TRANSPORT

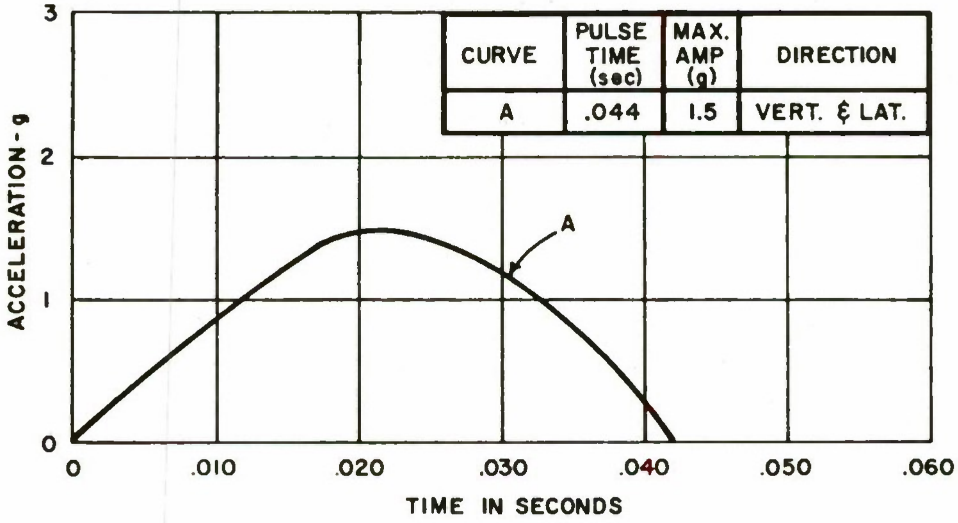
Figure 1.



SCHEMATIC (C-2 CLASS)



—VIBRATION, VERTICAL & LATERAL—



CURVE	PULSE TIME (sec)	MAX. AMP (g)	DIRECTION
A	.044	1.5	VERT. & LAT.

—SHOCK—

CARGO ENVIRONMENTS FOR SEA TRANSPORT

Figure 2.

frequency of the vibrations be accurately duplicated and that safety factors be applied in terms of the length of the vibration. It is recommended that the restraining system be designed to sustain the vibration for a period three times as long as would be anticipated based on the mission of the aircraft.

c. The shock acceleration normally occasioned by landing should be based on a velocity at touchdown for the aircraft of 10 feet per second. Again, any safety factors should be applied by increasing the number of shocks rather than the severity. It is recommended that the restraining system be capable of withstanding 20 landing shocks with no signs of failure or impending failure to any of the components.

d. Envelopes of the maximum data recorded in the Transportation Corps field studies thus far are shown in figure 3. These data are from tests in which short recording periods were used and where high input loadings were simulated consistent with test safety. It is anticipated that with the inclusion of data taken under emergency conditions, the accelerations will be somewhat higher.

7. Highway. *a.* For highway transportation, the cargo and its restraining system should be capable of sustaining the loadings incident to a 1,000-mile road trip over a paved highway in a condition described by AASHO*—PSI** index 1. For all shocks and vibrations, the stresses in the restraining system should not exceed the yield strength*** of the material, nor should they exceed one-half the yield strength*** of the material under static load conditions.

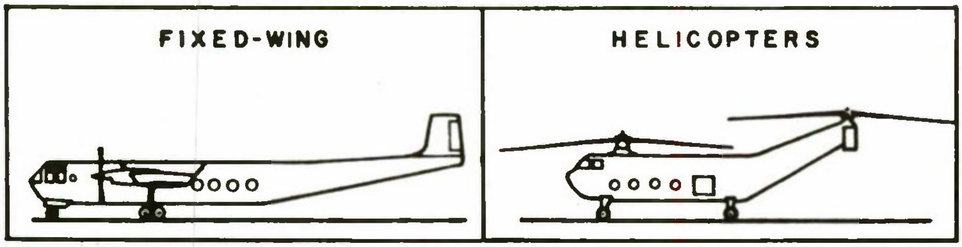
b. Envelopes of maximum values recorded during Transportation Corps field studies for both shock and vibration are shown in figure 4. It is recommended that the vibration time for design purposes be consistent with a 5,000-mile trip and that design safety factors, if any, be applied by increasing the time of vibration. For design purposes, it is recommended that the restraining items be designed to withstand 30 shock applications.

---

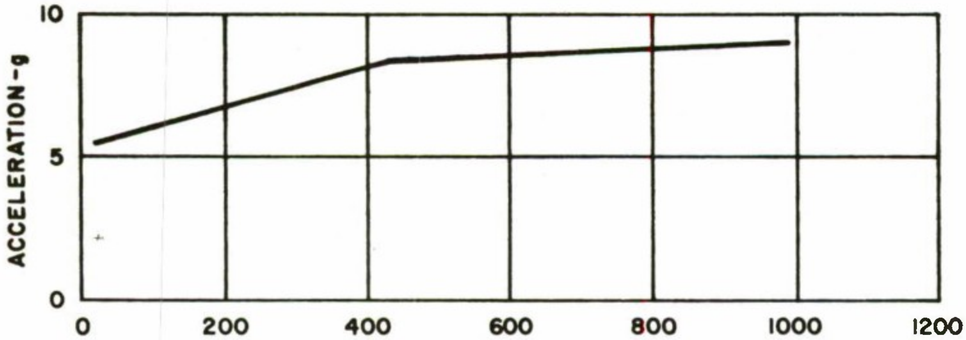
*AASHO—American Association of State Highway Officials.

**PSI—Present Serviceability Index, reference: Highway Research Board Special Report. No. 61-C.

***As published by the American Society for Testing Materials (ASTM).

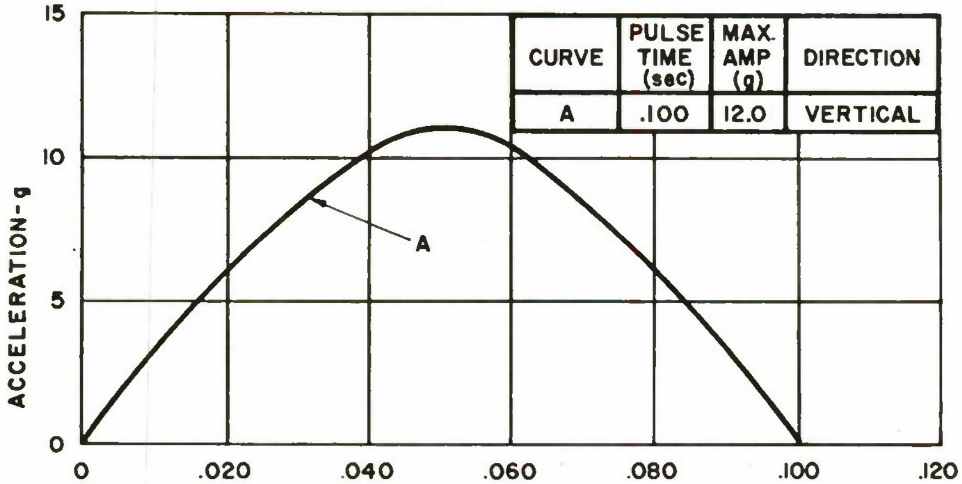


SCHEMATIC



FREQUENCY (cps)

— VIBRATION, VERTICAL - LATERAL - LONGITUDINAL —

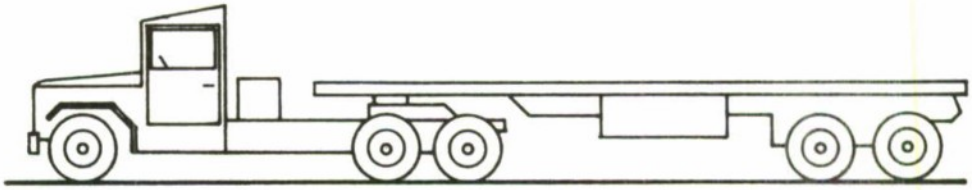


TIME IN SECONDS

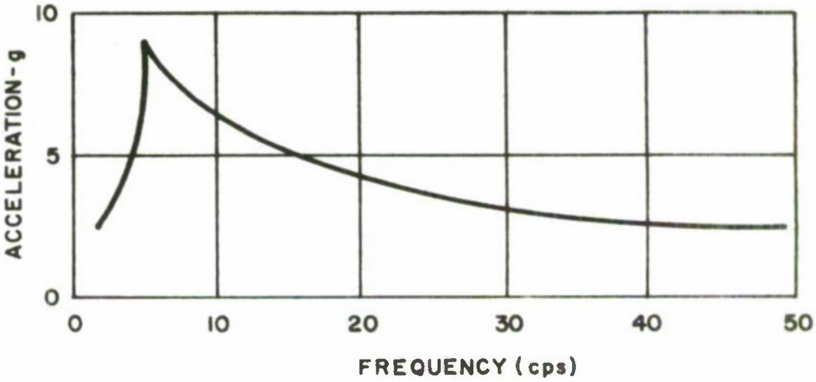
-SHOCK-

CARGO ENVIRONMENTS FOR AIR TRANSPORT

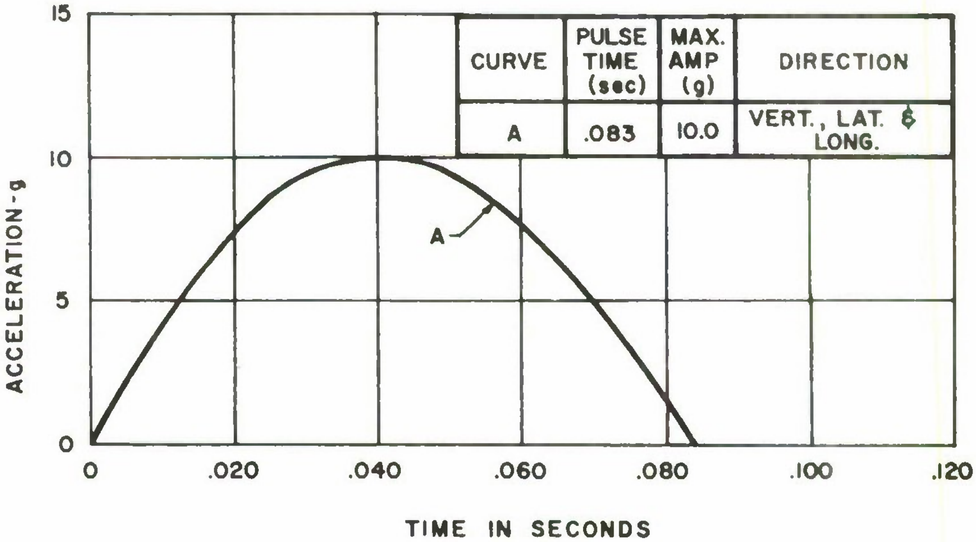
Figure 3.



SCHEMATIC



— *VIBRATION, VERTICAL* —



— *S H O C K* —

CARGO ENVIRONMENTS FOR HIGHWAY TRANSPORT

Figure 4.

By Order of the Secretary of the Army:

EARLE G. WHEELER,
General, United States Army,
Chief of Staff.

Official:

J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

Distribution:

Active Army:

DCSLOG (1)
CNGB (2)
C/Army Res (2)
CMH (2)
CofT (5)
CofEngrs (1)
TSG (1)
C/COMMEL (1)
USA CD Agcy (2)
USAMC (50)
USAMOCOM (2)
USCONARC (5)
ARADCOM (2)
ARADCOM Rgn (2)
OS Maj Comd (10)
OS Base Comd (2)
4th LOGCOMD (5)
MDW (2)
Armies (5)
29th Trans Bn (1)
Cen (2)
USACDC (5)
USATCDA (2)
Arsenals (2)
GENDEP (OS) (5)
Trans Sec, GENDEP (OS) (3)
Trans Dep (OS) (3)
Army Dep (2)
Instls (2)
USA Avn Mat Comd (50)
USA Trans Engr Agcy (50)
USATCDA (2)
POE (2)
Trans Tml Comd (2) except
USATTCA (20)
Army Tml (2)
USAOSA (1)
Svc Colleges (2)
Br Svc Sch (2)
USA Corps (1)

NG: State AG (3).
USAR: None.
For explanation of abbreviations used, see AR 320-50.

☆ U.S. Government Printing Office: 1964—700582

APPENDIX 8 to ANNEX A to Staff Study (Ammunition Container Criteria)

June 1970

DRAFT

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

Railroad Transportability Test Criteria

1. PURPOSE

a. This bulletin sets forth the Department of the Army interim transportability test criteria for guidance of research, development, test, and evaluation agencies (RDTE). Its secondary purpose is to standardize transportability test procedures to improve communication worth and interchangeability of test findings and develop and document information for use in the preparation of technical manuals setting forth the transportability guidance.

2. SCOPE

a. This bulletin includes criteria and related procedures used for the preparation of technical manuals setting forth the transportability guidance.

b. The information contained in this bulletin describes two test procedures. First is a proof test. The proof test does not describe scientifically developed transportability criteria but is included because it is often used as an official test to determine compliance with regulatory requirements. The second test is known as a failure test and sets forth procedures and instrumentation required to determine

scientifically the relationships between the forces transmitted to the item and the repetitive forces the item can withstand without loss of integrity.

3. SUMMARY OF METHODS

a. Method A, Proof Test. This method, commonly referred to as the Association of American Railroads' (AAR) Method, is used predominately as a go- or no-go test. It is the simplest of all impact test methods currently in use as it requires little instrumentation and can be performed at low cost. Method A test, proper documentation, and drawings are needed to obtain AAR approval to ship in CONUS and obtain listing of the restraint configuration in an official AAR publication. Applicability. Method A test is mandatory to obtain AAR approval for a new or modified blocking and bracing system. Method A is basically a railroad requirement for train safety.

b. Method B, Failure Test. When costs, fragility or military importance of an item are great, impact test, Method B, is conducted to determine either a technical comparison with other systems or a measured value for the failure load. Method B is familiarly known as the Department of the Army Technical Bulletin 55-100 Method. Its testing procedure gives reproducible data and facilitates precise comparisons by engineering mechanics and energy methods and provides for the establishment of a margin of safety. Both Method A and Method B tests have been used

extensively for the last 20 years by Government and industry; hence, back-up data for checking and comparative purposes are frequently available.

Applicability. Method B test is frequently conducted by industry and DOD agencies during and as part of the item development stage. The test is conducted at a time that the item or restraint can be improved to produce the desired failure load and the required margin of safety. Frequently, research organizations use this type test on modeled or simulated items to determine the design loadings prior to prototype construction.

3. METHOD A, PROOF TEST

a. Apparatus.

(1) Car types, weights. The test cargo or restraining system must be applied to a test car containing the minimum draft cushioning intended in service for the particular application. Five unspecified empty freight cars equipped with conventional draft gears are required for buffer cars for the impact test.

(2) Track site. A minimum distance of 300 feet is needed between the standing and striking cars to provide distance for the locomotive to accelerate the hammer car to the desired velocity. Allowing for the locomotive, test and buffer cars, reasonably level track in excess of 650 feet is required to conduct a Method A test.

(3) Car acceleration. A locomotive is normally used for car acceleration with Method A impacts as this test is predominately conducted at field sites. An inclined ramp facility to accelerate the

hammer car is preferred to give better striking car control and velocity precision. Normally it is impractical to move the cargo and test car to a central test facility with ramp.

b. Instrumentation.

(1) Impact velocity measurement. Electric timers triggered by switches placed adjacent to the test track ahead of the point of impact at a fixed distance are the preferred instrument for impact velocity determination. The switches are operated by passage of the hammer car. Alternate instrumentation used for remote field tests are stop watches and toy torpedoes.

(2) Shock measurement. Mechanical recording accelerometers are suggested as a performance check; however, they are not to be used to indicate the impact speed. The recorders should be nailed to car floor.

(3) Physical measurements. A still camera is normally used to document photographically impact test happenings. Markers or visual references should be placed at appropriate locations both for measurements and photographs to provide for specific measurements of motions or defections. High speed motion pictures are both advantageous and desirable, and may be required by the test plan.

c. Impact Procedure.

(1) Buffer car placement. The string of 5 empty buffer cars are placed with the air brakes set and the train slack removed. Buffer cars are repositioned after each impact. Brakes and slack should be checked with each positioning to minimize the changes in preimpact condition.

(2) Test car. The test car is accelerated by the locomotive to the desired velocity. The test car is uncoupled from the locomotive just prior to impact and allowed to roll free over the timing instrument and impact into the string of buffer cars.

(3) Impact speeds. For the initial orientation of the test car or test cargo, impacts are made at nominal speeds of 4, 6, and 8 mph. A fourth impact is required at 8 mph with the car turned end for end. If the test speed is not attained, the impact should be rerun.

(4) Option for reversed 8 mph impact. If field conditions prohibit test car reversal, to provide a substitute the test car may be placed at the impacted end of the string of buffer cars and impacted with a hammer car of equal or greater weight than the test car.

d. Field Documentation.

(1) Run numbers. Each impact should be given a sequential run number and this number should be used on all notes and instrument readings.

(2) Environmental notes. The date, weather, location, and time of tests should be part of the field notes. General description of the test track and its condition should be noted.

(3) Test procedures. Specific notes should be made regarding the test procedure. In particular, it should be noted how the reversed 8 mph impact requirement was met. Car number, type, and stencil information and location within the string of buffer cars should be noted for all cars used during test.

(4) Test observations. Notes need be made regarding happenings during test as tiedown yielding, car part deformations, load shift, or vertical bounce. Official and unofficial observers to the test should be noted.

(5) Sketches. Field sketches recommended to show tiedown arrangement, instrument and load location. For damaged or displaced items, photographs are preferred. Sketches with actual dimensions are required if a camera is not available to document damage.

(6) Mechanical accelerometers. The tapes should be marked with time, date, run number, test site location, and initials to show who advanced or removed the tape. The register should be checked after each impact and the tape advanced to separate the readings.

e. Report.

(1) General information. The report should indicate the background, date or dates of testing, the weather, and other environmental conditions. General condition of the test facility at the time of test should be included.

(2) Conclusion. Conclusions should be given, to include approvals, disapprovals, or major change in direction as a result of the test.

(3) Characteristics. The report should include the car characteristics, stencil information, and description of any new tiedown characteristics.

(4) Summary of field notes. The field notes should be collected, summarized, and documented by the report.

4. METHOD B, FAILURE TEST

a. Apparatus.

(1) Test car. The test car is either the car under study or the car containing the cargo or device under study.

(2) Hammer car. The hammer car should be rigid-type, 70-ton freight car such as a hopper or a gondola. The hammer car should be loaded to a maximum rail load of 220,000 pounds. The hammer car is usually part of the installation as it receives a great number of impacts in the process of impact loading other cars to failure. It is recommended that the hammer car be reinforced, especially in highly stressed areas to insure that failure during impact, if any, occurs on the test car.

(3) Test site. The impact test track site for Method B is normally a fixed installation. The site is comprised of 300 to 1,000 feet of level, well-ballasted track. The length of track is determined by the equipment used to accelerate the cars, stop the cars, and provide for safety. In general, more complex mechanical arrangements require shorter length of straight level track.

(4) Test car acceleration. Method B test requires accurate impact speed control. An incline ramp is normally used to accelerate the car as it can be calibrated and is more reliable to produce the desired impact speed. Many of these tests have been performed with a locomotive to

accelerate the hammer car. The incline ramp is preferred for speed attainment to minimize the possibility of exceeding the preselected speed.

(5) Braking after impact. The hammer and test car should be equipped with mechanical trippers that will apply the air brakes 10 to 20 feet beyond the impact point. Substitutes may be in the form of track skids or other devices that provide for a controlled gradual stop. In no case should the test and hammer car be allowed to impact freely into the back up or safety cars.

(6) Photography. Permanent fixtures, platforms, or camera and light mounts should be provided as part of the impact site. These should be located to provide a broad range of views of the test car and its cargo.

b. Instrumentation.

(1) Velocity measuring. Approximate velocity should be measured by using two switches set approximately ten feet apart actuated by the traversing of the hammer car. The switches are set to time the duration it takes for the hammer car to traverse the switches. An electric timer is required with direct reading of .01 second. The switches should be set as close to the impact point as possible to minimize rolling friction errors.

(2) Dynamometer coupler. At least one of the impacting couplers should be specially adapted to facilitate mounting of strain gages to provide for a continuous recording of the coupler force throughout the impact cycle. The dynamometer coupler should be designed and constructed to resist a compression load of 1,250,000 pounds without yielding. Prior to use the coupler

must be statically calibrated with instrumentation affixed and recording. A certified performance curve with cited calibration constants must be established.

(3) Transducers. All transducers must have a flat amplitude response from DC to 500 cps or higher. Transducers used to detect shock, vibration or internal forces must be compatible to the extent that all data record on the same or similar type recorders use the same time reference and simultaneous calibration.

(4) Recording equipment. Recorders must have a frequency response flat from at least DC to 500 cps. When more than one recorder is used one transducer or timing channel should appear on all recorders for synchronization. The dynamometer coupler output is recommended for multiple recording synchronization as it is normally the most basic measurement.

(5) Static measurements. Static measurement of all strain gages should be taken before and after impact to determine permanent set and keep track of pretensiled or precompressed forces.

(6) High-speed photographs. Sound speed motion pictures should be taken of each impact with an overall view of the test car. Special photographic studies of car components or cargo cushioning are normally made with a higher speed photography. Film size and frame speed should be selected in conjunction with the analysis or data reduction equipment available and the intended use for the films.

(7) Automation. All instrumentation should be selected to fit together as a complete system. Most of the measurements lend themselves

to reduction and analysis by automatic methods on either analog or digital computers. A prime goal for all instruments is that the output be compatible with automatic data processing.

c. Impact Procedure.

(1) Static measurements. Each impact must be given a number. All instrument and field measurements must refer to this run number. As the electronic instrumentation measures differences, static readings should be taken before and after each impact to detect change of the zero reading indicative yielding. Physical measurements of absolute cargo location, length of restraining cables, return to zero of cushioning units or other dimensional control measurements should be taken before and after each impact to insure that the change in location or dimension is accounted to the proper impact. If tiedowns or other components under study are precompressed or pretensiled prior to impact, this force must be measured so that it can be added to the dynamic reading from the electronic recording devices to get the true dynamic forces.

(2) Impact sequence. The Method B sequence is to accelerate the hammer car to the required velocity and allow it to roll free into the stationary test car. The test car stands alone with all brakes free. The couplers are set to prevent coupling during test impact. At approximately 10 feet after the point of impact the air brakes on each moving car are automatically tripped by car passage to provide a controlled stop for each car. Backup or safety cars with hand brakes set are normally

placed 50 feet to 100 feet down the track. The four or five unspecified railcars are to stop the moving cars in the event that the air brakes malfunction or are insufficient to stop cars at the desired distance.

(3) Impact speed. Impacts are run in 1 mph increments from 4 mph to 8 mph for general troop support cargoes and to 10 mph for priority, high-value, and sensitive cargoes. Normally it is required to advance the impact speed, in 1 mph increments, to failure to determine actual strength and margin of safety of the system. Successful items must withstand three impacts of maximum velocity (8 mph or 10 mph) in each direction without failure or signs of impending failure.

(4) Field notes. Complete field notes should be taken from the initial portions of the Method B test, as car loadings and instrument preparation, to the final inspection concluding tests.

(5) Instrument notes. Notes associated with the electronic recording instrumentation should be kept separate from the test notes as they are normally more predictable and repetitive. Calibrating constants or formulas should be kept in the instrument notes. The run numbers selected must be the same for field notes and instrument notes, and these should be checked for consistence during testing.

d. Analysis.

(1) Data reduction. The bulk of data reduction is to transpose electrical signals from recording equipment into amplitudes and frequencies or pulse times. Tabular data usually include such data as run number,

peak coupler force, peak accelerations, and maximum travels. Graphical data include time histories of coupler force, critical acceleration or force data, continuous travel data, and velocities or travels for cars or components. Statistical graphs or bar charts are also constructed as a data reduction function showing the percent of occurrence or population distribution.

(2) Energy analyses. Frequently the energy flow or power flow throughout the system must be determined for proper comparison or criteria preparation. A useful energy analysis can be made by considering the system as comprised of two or three masses and springs. Other analyses might require as many as 20 spring mass separations. The configuration, size, and information sought determine the method and extent of energy analyses. Energy analyses are frequently needed to determine the efficiency of tiedown or other cushioning devices in the system. In order to satisfy the requirement that the stress, static and dynamic, is below the yield for a given impact, it is necessary to perform stress analyses. These analyses are frequently performed in conjunction with and as a part of the energy analyses.

(3) Automation. Due to the high engineering costs associated with manual analyses, many rail impact analyses are performed on the computer with automatic methods. It is highly advisable to plan a Method B test for automation. It is necessary that source data and output from data reduction be in a form that is readily acceptable for a computer.

(4) Comparison. The basis of most analyses for Method B impact is comparisons of forces and strengths. The analysis formally compares one system's forces and energies against a sought or acceptable one or compares the performance against a standard. Method B type of testing has the additional requirement to test to failure or to determine the extent that the standard was exceeded. The comparisons are made either by peak readings, time histories, or statistical graphs depending on the criteria and the analysis needed.

e. Report.

(1) General. Method B test is conducted by numerous organizations and for a variety of reasons. This technical bulletin will cover items of a technical nature that might be overlooked, and it sh uld serve as a checklist to insure full reporting of the test findings.

(2) Tables. A tabular listing of the car characteristics for the hammer car and the test car should be included in the report. A tabular listing should be included of peak coupler force readings, peak acceleration readings with accompanying pulse time or frequency, mechanical accelerometer readings with associated frequency or pulse time, peak displacements for truck springs, and coupler or cargo displacements. All of the tabular data should be keyed to a specific run number.

(3) Curves. Plots or graphs should be prepared to show peak reading progression with increasing loads. Tabular data of peak amplitudes against coupler force or car velocity are frequently plotted to provide curve shape comparisons not readily apparent in the tabular data. Time history curves depicting a complete impact cycle should be

included at least for typical acceleration, displacement, and strain gage readings.

(4) Photographs. Minimum requirement of photographs in a Method B report would be an overall view of the test car showing the principal item being tested and a photograph of the failure that terminated the tests.

(5) Energy and stress analyses. These items should be handled as a separate portion of the report. Sample calculations showing all formulas, theories, and assumptions are normally sufficient for the report. All results should be listed. Comparisons made with other analyses or classical solutions should be shown. When analysis findings are compared with a criterion, the criterion should be shown and referenced as a part of the analysis.

(6) Summaries. Environmental data summary covering only data pertinent to the main test objective should be prepared in tabular form. This table should be included early in the report, preferably under conclusions, so that the principal findings will be immediately apparent in numerical form.

APPENDIX 9 to ANNEX A to Staff Study (Ammunition Container Criteria)

June 1970

DRAFT

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

Terminal Handling Transportability Test Criteria

1. PURPOSE

This bulletin sets forth the Department of the Army interim transportability test criteria for guidance of research, development, test, and evaluation (RDTE) agencies. Its second purpose is to standardize transportability test procedures to improve communication value, interchangeability of test findings and develop and document information for use in the preparation of technical manuals setting forth the transportability guidance.

2. SCOPE

a. This bulletin includes criteria and related procedures used for the preparation of technical manuals setting forth the transportability guidance.

b. The information contained in this bulletin describes two test procedures. First is a proof test. The second is known as a failure test. The proof test does not describe scientifically developed transportability criteria but is included because it is often used as an official test to determine compliance with regulatory requirements. The second test sets forth procedures and instrumentation required

to determine scientifically the relationship between the forces transmitted to the item and the repetitive forces the item can withstand without loss of integrity.

3. SUMMARY OF METHODS

a. Method A, Proof Tests. This method applies a sequence of simulated handling shocks to the test specimens. Impact velocities are controlled principally by releasing the specimen from premeasured drop heights or by precalibrating the laboratory simulator to obtain consistent inputs. Visual observations of specimen failure are the criteria for determining compliance with proofing requirements. Method A provides an economical test for high volume specimen testing. The tests produce no basic data on sub-failure conditions; however, they are quite effective as a proof test to insure compliance with minimal fragility levels. Method A tests are useful for comparing large numbers of restraining designs for sorting or classifying.

Applicability. The military, industry, and research organizations frequently specify Method A proof tests when every item or every restraining system in a lot need be certified that it will withstand a preestablished handling load. Method A tests also apply as an economical comparison test when many arrangements need to be tried prior to prototype design. Method A tests produce a reproducible shock base when various environments as moisture, temperature, and humidity are the prime test parameters, hence, they are used extensively for preliminary tests.

b. Method B, Failure Tests. When a need exists to establish the exact failure load or the margin of safety, a Method B type test is

required. The Method B tests are similar to Method A tests as regards methods of loading. For Method B tests, both the laboratory fixture and the test specimen are instrumented to obtain the force, energy, and stress flow through the system during the shock-loading cycles. The loading severity for Method B tests is progressively increased to establish the point of failure or impending failure indicated by the instruments.

Applicability. Method B tests are normally applied to obtain basic data and are conducted during or before the prototype stage. These tests are suitable tests for development requirements as structural improvements and changes during the testing sequence are encouraged to establish the best economic design and highest failure loads.

4. METHOD A, PROOF TESTS

a. Incline Impact Test.

(1) Apparatus. The incline apparatus is a stationary rail incline approximately 24 feet long to which is affixed track consisting of a pair of 1-1/4-inch by 1-1/4-inch angle irons. The upright flanges comprise the wheel guide and the horizontal flanges are the wheel track. The track gage is 2 feet 9-5/8 inches. The incline is 10 degrees from the horizontal. A small platform dolly with a 2-foot-8 inch axle center and wheel gage to suit the track gage is used to transport the test specimens and attain the necessary impact velocity. A substantially rigid backstop constructed of lumber completes the major components of the apparatus. A winch and cable are used to elevate the dolly and test item. A tripping device is incorporated to release the dolly and test

specimen to allow it to roll down the incline and impact into the backstop. A description of the incline test apparatus and procedures are found in American Society for Testing and Materials Standards, Part 15, D880-63T. A detailed description of the apparatus with construction drawings appears in Freight Container Bulletin 673, Freight Loading and Container Section, Association of American Railroads.

(2) Instrumentation. The incline is graduated in 6-inch increments of track length, and these increments are transposed by calibration into increments of impact velocity. A counting device is frequently used to record the number of impacts. Due to the changes in rolling friction occasioned by temperature and wear, it is advisable that switches actuated by passage of the dolly and an electric timer be used to measure the velocity for each impact. Mechanical accelerometers attached to the test item are recommended for Method A tests to obtain an indication of the inertia loads transmitted to the test items. Mechanical accelerometers shall not be used to measure the impact velocity.

(3) Procedure. The item to be proof tested is placed on the dolly with the impacted face of the test item protruding 2 inches beyond the dolly to insure that the initial contact is made between the face of the test item and the backstop. If the item does not have a flat surface suitable for impact against the backstop, a bearing adapter must be applied to insure distribution of the impact load on the specimen. One impact is performed on each of two opposite ends of the test specimen. The dolly and test specimen are released from 5.5 feet up the incline for each impact. Successful completion of the proof test is normally

determined by fragility checks after impacts as specified in the test plan. Physical measurements of locations of reference points are made after each impact and a thorough inspection of the test specimen as regards abrasion, cracks, failure or signs of impending failure is required after each impact. Normally a minimum of five specimens are proof tested; however, this requirement will vary considerably dependent on the requirements of the test plan.

b. Pendulum Test.

(1) Apparatus. A variety of apparatus have been used successfully for the pendulum test and the majority of these are custom made to suit the existing structure and facilities of the test laboratory. The test specimen is suspended on steel cables which are attached to a framed structure. Elevation of the load by swing of the pendulum is normally accomplished by a horizontal pull with a winch and cable. A trigger or release mechanism is required to release the test load at the proper vertical elevation. Sufficient laboratory space need be provided so that the specimen can be elevated 24 inches with the pendulum swing. A vertical backstop is required to provide a substantially rigid mass for the specimen mass impact at the bottom of the pendulum swing. The backstop need be substantially rigid and unyielding to minimize backstop motion during impact.

(2) Instrumentation. A measuring device accurate to plus or minus .05 inch is required to determine the change in elevation of test specimen due to the pendulum swing. Mechanical accelerometers mounted

on the test item are recommended to indicate the shock resulting from the pendulum impact, but they should not be used to indicate the velocity of impact. Measuring devices are required to establish the amount of yielding or changes in dimensions of the test item. A camera is required to record damage occasioned by pendulum impact.

(3) Procedure. The item to be proof tested in its shipping configuration is suspended on cables 10 to 20 feet long. If inadequate lifting points are available the item may be placed on a suspended pallet but care must be taken to insure a 2-inch test item projection beyond the pallet to insure that the initial impact is made with the test item. If the item has no flat surface for impact, a wood hammer surface may be built on the test item but it shall not be affixed to the pallet. The test configuration is pulled horizontally until the required elevation is reached. The releasing mechanism is tripped allowing a free pendulum swing into the backstop to cause the impact. One impact is required for each of two opposite ends with a 11-inch change of elevation measured from the starting point to the bottom of the pendulum swing. After each impact the item is completely inspected and photographed. Successful completion of the proof test is dependent on checks of item soundness called for in the basic test plan for the item. Normally at least five test items need be proof tested. This requirement can vary from one to all production items dependent on the basic intent of the test. For general transportability test adherence five test items need successfully withstand the proofing load without failure or signs of impending failure.

c. Drop Test.

(1) Apparatus. The primary apparatus for drop tests are handling equipment for the test item as tractors, cranes, and jacks. Standard handling equipment are suitable for hoisting the test item in position prior to the drop. Triggering and releasing mechanisms that insure a sudden release of the load are required. Blocks or other elevating devices are required as the entire item need be raised from the surface and supported prior to the drop. A hard, solid surface is required for the impact surface.

(2) Instrumentation. Rules, tapes, dial indicators and string lines comprise the principal instrumentation for drop tests. Care must be taken to assure that the height of drop is accurately determined. Methods using standard measuring instruments must be devised for each test item to measure the amounts of fracture, deformation or distortion. Mechanical accelerometers are encouraged to establish the test item shock response-drop height relationship. A still camera is required to record damages or test effects that are not accurately described by measurement.

(3) Procedure.

(a) Edge drop. The test item in the shipping condition, fully loaded, is placed with one edge supported on a timber to raise it above the ground line. The other edge is lifted to the desired drop height where prior to release an accurate measurement of the drop height is taken. The lifting force is rapidly released by cutting a strap or

some other release mechanism and the resulting impact is made between the test specimen edge and the hard landing surface. For transportability compliance with the proof load, it is necessary that the item withstand two drops of 12 inchs for each of the two ends for specimens over 1,000 pounds.

(b) Corner drop. For the corner drop a 4-inch to 10-inch block is placed under one of the corners already supported to cause the impact on the diagonally opposite corner. The other end of the test specimen is raised to the desired elevation and its position is carefully measured and recorded. For transportability compliance with the proof load requirement, the test item must withstand two 12-inch drops on each of two diagonally opposite bottom corners for specimens over 1,000 pounds.

d. Stacking Load, Grab Hook and Sling Tests.

(1) Apparatus. The stacking test is normally conducted by applying weights to the top of the container. A crane or other suitable lifting device of sufficient capacity is required to have adequate control over the test loadings. Convenient weights, concrete blocks with handling fittings, are required in sufficient amount to conduct the stacking tests. The same paved hard surface used for drop testing is suitable for stacking tests. Grab hooks and slings representative of intended service items are required for proof tests. The number and size of hooks and slings required is dependent on the size, weight, and design of the item being tested.

(2) Instrumentation. For the stacking, grab hook, and sling tests, string lines affixed to the item are required to measure deflection, bulge, or permanent distortions. A camera is required to record the test rigging and load application as well as any damage consequent to the proof tests.

(3) Procedure. The test item shall be in the shipping configuration for tests. The test item is carefully inspected prior to test with particular attention given to panel bulge, connections, and all structural items anticipated to be highly loaded by tests. A stacking load is selected based on the maximum stacking load due to handling anticipated in service. The stacking load is placed on top of the test item and allowed to remain for 10 minutes. Physical measurements are taken of panel bow (top, bottom, and sides) deflections and distortions due to the stacking load. Photographs of pertinent information and physical measurements are required before, during, and after loading. For the grab hook test the item should be lifted by grab hooks with the cables at an angle of approximately 45 degrees. It should be held suspended for 5 minutes during which time measurements are taken as regards item bulge or deflection. After the test item is returned to the surface it is again measured to determine permanent distortions. The sling test is similar to the grab hook test except that the item is lifted with the slings around the bottom and sides of the test specimen. Proof tests of grab hook and sling types should be applied to all specimens except cargoes where provision has been made to insure that the specimens will not be handled in this manner in service.

e. Report.

(1) General information. The report shall include environmental information as weather, temperature, and humidity. The organization conducting and sponsoring the proof tests as well as names of the test personnel, observers to the test, and approving authorities are needed. General descriptions of the test item and packing and description to the test apparatus are required for the report.

(2) Conclusion. Early in the report the conclusion as to the item's ability to withstand the handling proof loads must be covered. For failures or marginal acceptance of an item's performance, a brief description of the specific test result should be given.

(3) Characteristics. The report must cover the physical and mechanical description of the test apparatus and facility and the physical characteristics of the items undergoing test such as weight, flexibility, packing, preservative and center of gravity. The rated loads of lifting devices and access for forklift or other lifting or handling devices should be included.

(4) Summary of field notes. Field notes including all measurements taken in the field should be summarized and made part of the report. Sketches and information keying the tests to data should be included.

(5) Measurements and instrument readings. All measurements and instrument readings taken during the test should be shown in the report in tabular form. Other methods of data presentation as bar charts and graphs are recommended where applicable. Distortions of the test

item either permanent or deflections under load should be presented as a sketch or graph with the measured amounts of maximum deflection noted.

5. METHOD B, FAILURE TEST

a. Incline Impact Test.

(1) Apparatus. For Method B tests the incline test ramp shall be calibrated for impact velocity and periodically checked and recalibrated. The dolly shall be so constructed to provide either for impact between the specimen and the barrier as in Method A tests or impact between the dolly and the barrier to test with inertia load on the specimen. As Method A test is a test to failure of the item, all apparatus must be constructed to withstand high loads to insure failure occurs to the test specimen. Apparatus need be available at the test location to weigh components accurately and subassemblies and to measure the centers of gravity in three planes for the items.

(2) Instrumentation. Electronic transducers and recording equipment are required for Method B tests. Accelerometers, strain gages, velocity, and displacement transducers are required and all need be established with the same time base for synchronization. Each impact must be timed using an electric clock timing passage over a fixed distance for velocity determination. There must be a sufficient number of transducers properly located on the test specimen to enable determination of the dynamic force flow and measured determination for the margins of safety. The backstop shall be instrumented with force gages in such a manner to

provide for measurement of the total force of impact. Mechanical instruments are recommended for Method B to provide a check against continuously recording electronic instruments.

(3) Procedure. Each impact for a given program should be assigned a sequential run number. This run number should be maintained in all notes and records. If impacts are rerun due to insufficient speed or lack of data, the rerun impacts should be assigned the next number. Impacts for each of the two item ends are conducted at ramp distances of 1-foot increments from 2 feet to a height that produces failure or signs of impending failure. The margin of safety is based on 5.5-foot incline height as the minimum acceptable for both ends. If an item withstands a 10-foot-incline impact, the margin of safety would be $1-\frac{5.5}{10}$, or 45 percent. Inspection of the test item is to be made after each impact. During this inspection mechanical measuring devices or measurements between index points should be taken and recorded. High speed photos (128 frames per second) are required for the high load impacts. Overall views are preferred unless the principal locations of interest are known.

(4) Analysis. Plots are required of peak backstop force versus impact velocity and one or more time histories of backstop force for key impacts. Acceleration, displacement, or force plots are required and should be graphed against either impact velocity or backstop force. When several spring masses or individual structural components can be isolated a complete force flow and force balance is required to establish

the various margins of safety for the system components. Energy flows are also required on items that contain cushioning that either amplified or attenuates the handling shock loads. This test is frequently conducted in conjunction with environmental factors as temperature and humidity. The analysis required is substantially the same as for regular handling tests except that the machanics must be separated to attribute the decrease in margin of safety to the proper environmental effect.

b. Pendulum Test.

(1) Apparatus. The pendulum test apparatus for Method B is substantially the same as required for Method A except that it must be much stronger to withstand higher impact forces and it must be more instrumented to attain the precision required for analysis and development of margins of safety. The apparatus must provide for either the impact of the test specimen against the backstop or the impact of the suspended platform, to which the specimen is secured, against the backstop. The backstop must be so constructed to provide for continuously recording instrumentation to measure the entire force of impact. The backstop must be extremely rigid with little motion consequent to impact to make the impact height criteria meaningful.

(2) Instrumentation. For Method B tests the apparatus and test specimen must be instrumented for continuously recording dynamic instrumentation. Either tape recording or direct readout oscillographs are acceptable but they must be capable of recording substantially undistorted shocks in the range from 0 to 500 cycles per second. Transducers

are required to measure acceleration, force, and displacements. The backstop must be so constructed and instrumented to provide for measurement of the entire impact forces by applying strain gage transducers to structural members that will total the impact force. The instrumentation must be so arranged that all transducers including the backstop gages have a common time base. It is advisable if more than one recorder is utilized to record the backstop dynamometers on all recorders. Instrumentation need be provided to measure the pendulum impact velocity for each impact.

(3) Procedure. Each impact shall be assigned an official sequential run number, and this number is used for identification of data throughout the duration of the test program. An impact is made by a sudden release of the test specimen from the predetermined pendulum height (vertical distance from release point to the impact point). Impacts are made on each of two opposite ends at 1-inch intervals.

c. Analysis. Pendulum height versus peak impact force are recorded as key data. Nonlinearity or yielding of any portion of the test specimen should be readily apparent on this curve. A force balance should be determined for a substantial and continuous portion of the cycle. For Method B failure tests, energy analysis and balance are frequently required especially when the test specimen is comprised of components with many separate natural frequencies. When this test is conducted in conjuction with a temperature of humidity environment it is necessary to analyze and crossplot all shock, vibration, temperature, and humidity findings. The margin of safety is based on an 11-inch height.

d. Drop Tests.

(1) Apparatus. A crane, hoist, or other suitable device that will lift the specimen and suspend it at the proper height without vibration is required. A tripping device that will provide a sudden and mechanical reproducible release of the specimen is required. Drawings and descriptions of several suitable drop test apparatus are given in American Society for Testing and Materials Standard D775-61. High-speed photographic apparatus are required for coverage of both individual components and overall specimen. A hard stand or suitable arresting surface is required as well as bracing and positioning components to produce consistent and reproducible end and corner drop tests. Many specimen specifications for drop tests require environmental chambers for conditioning the test specimen prior to drop. Some drop tests require facilities for performing the drop in the extreme environment. Apparatus required for either of the above conditions are special made for the specific specimen test requirement or adapted from existing facilities.

(2) Instrumentation. For Method B drop test, the drop surface should be instrumented to measure the total force of the drop throughout the entire shock cycle. This can be accomplished by isolating the impact forces by column support of the contact plate and measurement of the forces through the columns. Sufficient numbers of strain gages and accelerometers should be applied to the test specimen to provide for force and energy analysis both for individual components and the complete spring mass

system. Distortion measuring devices and other instruments that are peculiar to the specimen failure criteria are required. Recordings should be made on a multichannel FM tape recorder to provide for playback and analysis of data for various frequency bands. Automatic data reduction and analysis should be used for this type of test, and some existing drop test facilities are now fully automatic as regards data analysis and reduction.

(3) Procedure. A review of the existing drop test procedures discloses advantages to designing the procedure to fit the problem or the data sought. Many of current procedures account for sampling techniques, various failure criteria, and risk and reliability factors. These extensive procedures can only be used when the end result is worth the high testing costs or safety confidence. The following drop-test procedure is suggested as a general purpose procedure suitable for many test situations. Edgewise drops are required. Two drops are on each end, starting at 2-inch drop height and increasing in 2-inch intervals until failure. Cornerwise drops are required, two on each of two diagonally opposite bottom corners starting at 2-inch drop height and increasing in 2-inch intervals until failure. The margin of safety for edgewise and cornerwise drop is based on a drop height of 12 inches. If the item failed during an 18-inch drop, the margin of safety expressed as percent would be 1 minus the ratio of 12 inches divided by the drop height at failure or $MS = 1 - \frac{12}{18} = 33\%$.

(4) Analysis. The analysis should include the peak readings of the forces and accelerations in conjunction with the associated impact velocities and frequencies. Energy studies are needed for drop tests especially when the failure criteria are beyond the elastic limits. Normally the drop tests produce more than one failure, hence, margins of safety should be calculated for all marginal components to indicate the balance of the specimen design. For humidity, temperature, and pressure analysis in conjunction with shock and vibration, care is required to show histories of the specimen environment to better identify the nature and course of the failures.

e. Stacking, Lifting, and Sling Tests.

(1) Apparatus. Due to the numerous ways in which a specimen is lifted, slung, and stacked in service, the handling apparatus is normally selected to fit the items and the planned usage of the items. Particular attention is required to simulate lifting hooks or spreader bars as these components affect seriously the load distribution. All of these tests are dependent on increasing the test weight of the specimen to produce failure; hence, proper test weights with handling provisions are required as apparatus. Most of the lifting and handling apparatus will be the actual items used in service with appropriate instruments added for measuring stresses and forces.

(2) Instrumentation. Most of the instrumentation including transducers and recording equipment, will be the same as used for previous tests. Additional attention will have to be given to instrument near the lifting points or other areas that are highly loaded for this series of tests only. Photography and deflection measurements should use basically the same instrumentation relocated to cover the new points of interest.

(3) Procedure. For the stacking load tests, stacking weights are added to the base specified weights in appropriate increments until failure or impending failure occurs as indicated by the instrumentation. Test time at the given weight is 10 minutes. The margin of safety expressed as a percentage is calculated as 1 minus the ratio of the base load divided by the failure load. If the specimen is specified to withstand 300,000 pounds stacking load and impending failure is detected at 400,000 pounds, the margin of safety, $MS = 1 - \frac{300,000}{400,000}$ or 25%. Lifting and slinging tests are conducted the same way by increasing the specimen weight to the point of failure.

(4) Analysis. Stress analysis is normally the prime consideration for this series of tests. Complete force flow and margins of safety are required for all major specimen components and for all highly stressed components.

f. Report. The report should cover all facets of the test and analysis. Instrument locations should be shown and the type, range and reliability of the specific instruments should be indicated. Most of the handling tests have several procedure options. The particular procedure options used

should be given in the report. Engineering data should be substantially complete for tables and graphs and stress and analysis summaries, and should be included in the report. Computer programs and pertinent laboratory notes should be summarized and explained in the report. Before and after test, specimen conditions as well as failures are to be given as photographs for clarity and documentation.

APPENDIX 10 to ANNEX A to Staff Study (Ammunition Container Criteria)

June 1970

DRAFT

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

Highway Transportability Test Criteria

1. PURPOSE

This bulletin sets forth the Department of the Army interim transportability test criteria for guidance of research, development, test, and evaluation agencies (RDTE). Its secondary purpose is to standardize transportability test procedures to improve communication worth and interchangeability of test findings and develop and document information for use in the preparation of technical manuals setting forth the transportability guidance.

2. SCOPE

a. This bulletin includes criteria and related procedures used for the preparation of technical manuals setting forth the transportability guidance.

b. The information contained in this bulletin describes three test procedures. First is a proof test. The second is known as a failure test and the third is an over-the-road environmental test. The proof test does not describe scientifically developed transportability criteria but is included because it is often needed as an official test to determine compliance with regulatory requirements. The second test sets forth procedures and instrumentation required to determine scientifically the relationship between the forces transmitted to the item and the repetitive forces the item can withstand without loss of integrity. The over-the-road

environment test is intended for items whose mechanical characteristics are so greatly different from standard highway equipment as to require tests over the actual roads anticipated for service.

3. SUMMARY OF METHODS

a. Method A, Road Course Proof Test. Highway vehicles are run over a specifically constructed and calibrated road course. The pavements or highway surface are constructed to a standardized pattern of bumps to provide a reproducible input base at any test location.

Applicability. Method A is usually performed during the advanced development stage of a highway transportation system as a prototype vehicle is needed for test. Considerable test history and accumulated data are available for Method A tests for comparison and checking purposes and several test sites are now existent and in continuing use.

b. Method B Laboratory Failure Tests. Either the complete vehicle and cargo or major system components comprise the test samples used in the laboratory with the input loads supplied by shock, vibration, or special dynamic load-producing devices. For the Method B test, the sample is mounted in a jig or fixture, instrumented and a laboratory simulated transportation load is supplied. The instrumentation is usually more dependable and simple than for other tests because it is not undergoing dynamic load during test. The most important feature of a Method B test is that the loads can be safely increased to produce component failure.

The failure stresses and loads can be accurately determined to produce a reproducible margin of safety.

Applicability. Method B is intended for use during the development of the system prior to the time of establishment of a prototype. Often Method B will have to be used on the end item to determine the margin of safety when expense or hazards of the system preclude testing complete items to maximum loadings.

c. Method C, Over-the-Road Environment Tests. Highway vehicles and/or their cargo are instrumented; the vehicle driven over public roads and resulting dynamic forces and accelerations are electronically recorded for Method C tests. The purpose of a Method C test is to obtain specific and particular in-service response of the transportation system. Statistical analysis is applied to the measured data to extrapolate and project to high or design loadings.

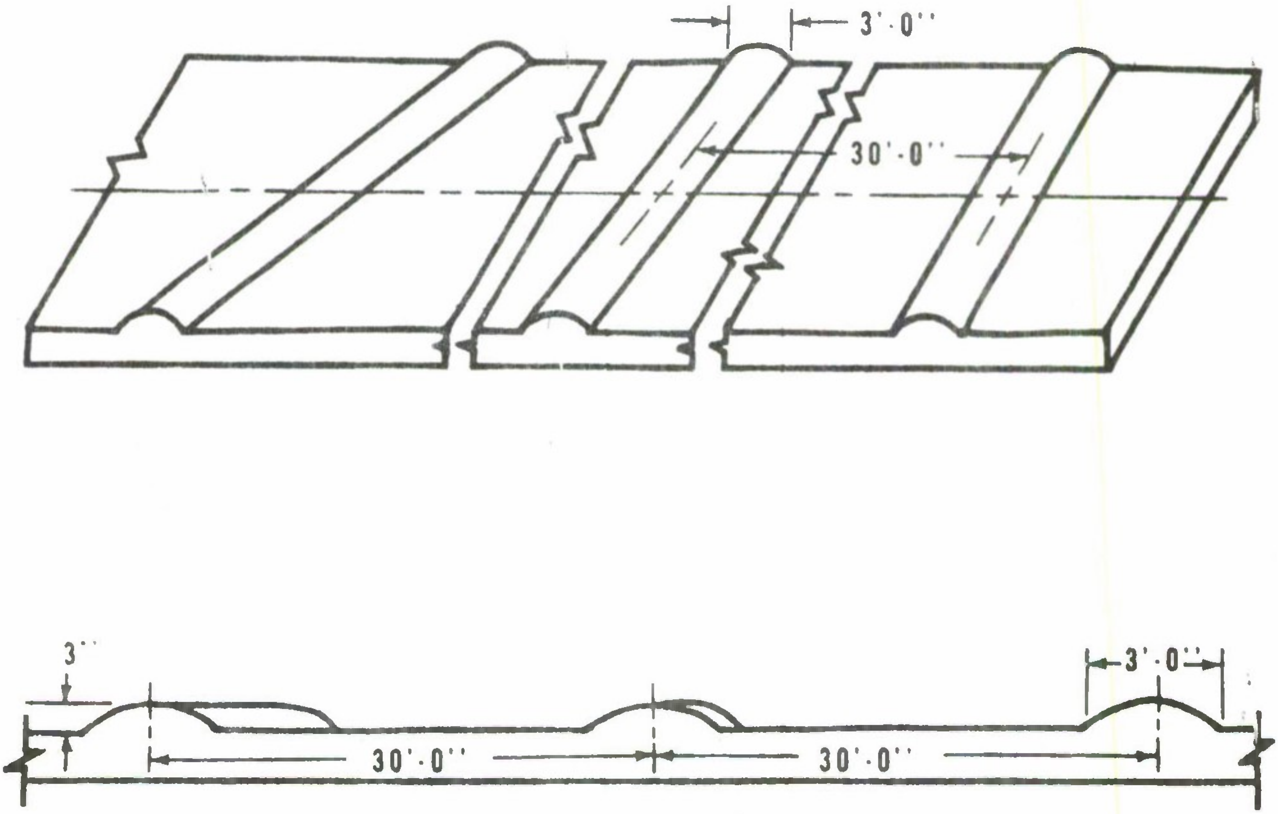
Applicability. Method C tests are used by military and commercial organizations when cargo restraining systems in the system require evaluation beyond Method A and B tests due to either their peculiar response or the small difference between the maximum anticipated environment and item fragility.

4. METHOD A, ROAD COURSE PROOF TEST

a. Apparatus.

(1) A general sketch of the spaced bump course is given in Figure 1. This course consists of a series of rounded pavement bumps 3 inches high by 3 feet wide, spaced at intervals of 30 feet measured at the

SPACED BUMP COURSE



LONGITUDINAL SECTION

Figure 1

centerline. The bumps extend the entire width of the pavement and are skewed from the perpendicular in the following sequence starting with perpendicular 90°, 90°, 67°, 52°, 90°, 90°, 113°, 128°, 90°, 90°. This sequence extends for 26 bumps, or 831 feet of pavement.

(2) The second precontoured pavement used for Method A tests is known as the 2-inch washboard course as shown in Figure 2. The surface shape is a series of continuous uniform waves extending the entire width of the pavement and perpendicular to the centerline. The double amplitude, the vertical distance from bottom of depressions to top point of crest, is 2 inches. A complete cycle, horizontal distance between two top points or two valley bottoms, is 2 feet. The pattern extends the full width and length, 300 feet, of the concrete course surface.

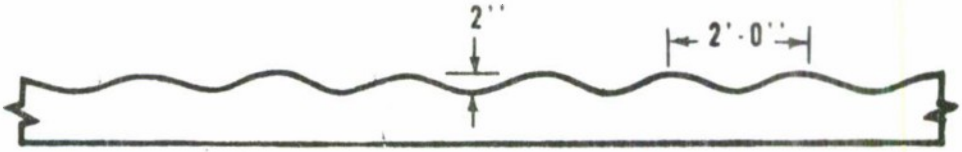
(3) The test course used for tracked vehicles in Method A tests is the spaced ramp course as shown in Figure 3. Separate ramps 4- by 6-feet by 6 inches high are applied to a bituminous concrete paved surface. The ramps are placed 3-1/2 feet on both sides of the centerline and are spaced along the roadway in multiples of 14 feet as shown in the sketch. The spaced ramp course is approximately 200 feet long.

b. Instrumentation.

(1) Speed measurement. Due to the high degree of tire bounce and wheel slippage experienced on Method A tests, the official speed recording should be made with a pacing vehicle.

(2) Frequency response. The entire recording system should have a flat response from DC to 500 cps.

2-INCH WASHBOARD COURSE

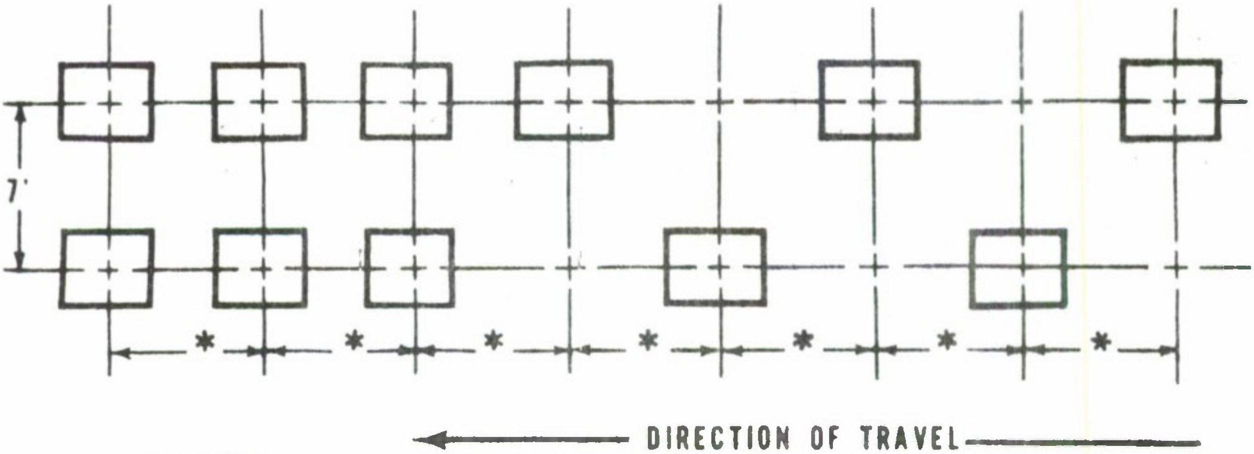


THE PROFILE APPROACHES A SINE WAVE WITH A DOUBLE AMPLITUDE OF TWO INCHES AND A COMPLETE CYCLE OCCURRING EVERY TWO FEET TO A DISTANCE OF APPROXIMATELY 300 FEET. THE COURSE SURFACE IS CONCRETE.

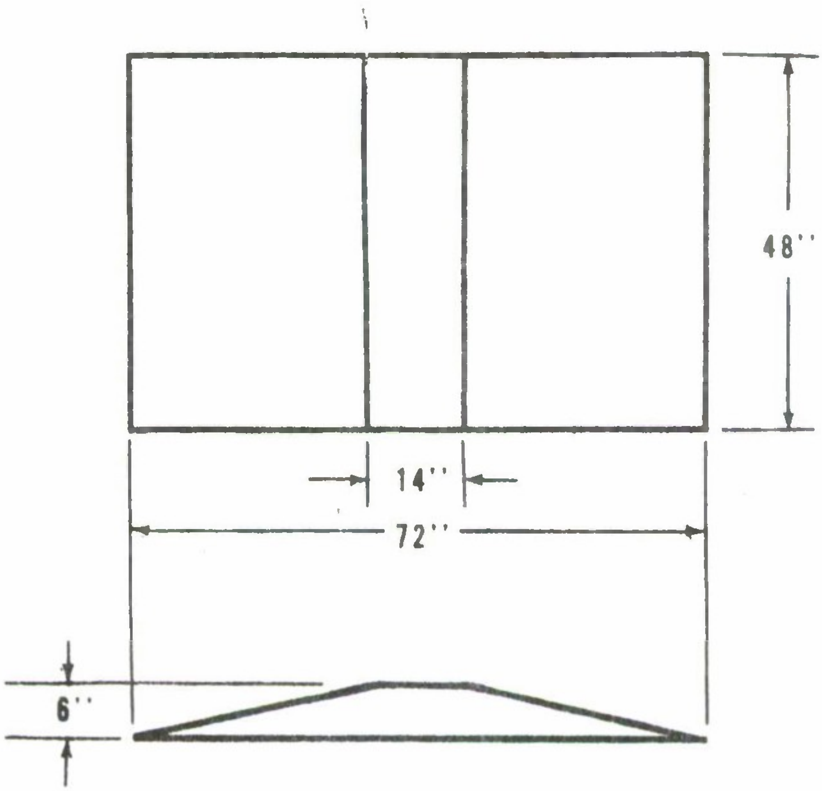
Figure 2

DIAGRAM OF SPACING FOR RAMP COURSE

(RAMPS PLACED ON BITUMINOUS CONCRETE SURFACE)



* — 14 FEET



RAMP DIMENSIONS

Figure 3

c. Test Procedure.

(1) Static measurements. All items used for Method A test should be weighed and certified.

(2) Speed sequence. The speed at which the vehicle is to be run over the test pavements is the same as the design speed for the vehicle under similar conditions of load and running surface as found in the equipment specifications. If the vehicle cannot reach the design speed due to either driver limitations, vehicle instability, or damage to the vehicle running gear, the test should be conducted at the highest possible speed with it noted that the vehicle did not comply with desired performance speed. In order to obtain a particular test speed, two passes at 5 mph increments, starting at 5 mph, should be run until the design or maximum speed is reached. Shocks and vibrations for these runs would be recorded to develop data at various speeds.

(3) Road course pass schedule. For wheeled vehicles 43 passes are required over the spaced bump course, Figure 1; and 43 passes over the 2-inch washboard course, Figure 2. For tracked vehicles 63 passes over the spaced ramp course, Figure 3, are required. These passes are in addition to those required to obtain the maximum test speed.

(4) Inspection. After every five passes over the test course the entire vehicle load combination should be inspected and the findings documented. Particular attention should be given to signs of failure or impending failure of any of the components. Marks or

other reference points should be used to determine accurately quantitatively such happenings as permanent load shifting, slippage, loosing of the tiedowns, or permanent set in any of the vehicles or cargo members. All of these measurements should be taken during inspection and recorded. Mechanical instrumentation, if any, should be read and recorded as part of the inspection procedure.

d. Analysis.

(1) Data reduction. The primary function of data reduction is to take the records from the test and transpose these displays into acceleration and time data for analysis. Whether this is performed automatically or manually the information must be well organized and in proper scale. The data depicting the shock and vibration measurements should be reduced both to tabular form showing the time during test the measurements were taken and in graphical form showing the buildup for speed increases or course severity.

(2) Comparison. The most popular and straight forward analysis used for Method A tests is direct comparison. These comparisons are simply comparing the measured data against a predetermined criterion to indicate satisfactory performance.

e. Report.

(1) General. Most reports are peculiar to and designed by the organization charged with the task. The items delineated in this regulation are for the purpose of insuring maximum interchange of data. The report should include general information as to purpose,

sponsor, and approval authorities. A general description of the test course and any local differences should be included.

(2) Tables. All summing data should be given in tabular form as peak accelerometer readings, frequencies, mechanical data, and maximum displacements for all test passes.

(3) Photographs. Still photographs showing the vehicle and road course prior to test are essential. Photographs are recommended to document progressive slippage or wear of tested components during test. Photographs showing the instruments in place are also recommended. If motion or high-speed photographs are used during tests, several frames showing the sequence and marked for the appropriate time should be included in the report.

5. METHOD B, LABORATORY FAILURE TESTS

a. Procedure

(1) Shock Loading. The following loadings are specified for the cargo bed or the interface between the cargo and the vehicle. The shock directions are vertical, lateral, and longitudinal. In order to establish progression, the shocks should be run with the following sequence: for each principal direction one each of 4g's at 20 ms, 6g's at 40 ms, 8g's at 60 ms, 10g's at 80 ms. After the 10g's is attained, an additional nine 10g impacts at 80 ms are required.

(2) Failure load. One major advantage of Method B tests is the ability to extend to failure loads under laboratory control. After applying the thirty 10g shocks, the shock input should be increased at increments of 5g's until a failure load has been reached. This point

is needed to determine the margin of safety. The failure is determined when signs of yield, collapse, buckling, or fatigue are apparent from instrument readings or from visual observations.

(3) Modification. Method B is a laboratory test, and it is the intent that modifications to components or structures to improve resistance to load are encouraged during the course of testing. When structural changes or improvements are made, it is only necessary to repeat the affected parts of the test sequence or to the point where nonelastic behaviour was first detected.

(4) Vibration tests. It is the intent of Method B vibration tests to subject components of the vehicle load combination to vibrations simulating those it encounters in transit. The input load base is established at the cargo bed or the interface between the cargo and the vehicle.

(5) Resonance search. A sweep of 2 cps to 50 cps in 10 minutes is required for a resonance search. The entire structure should be surveyed with a strobe light and an optical amplitude measuring device. Record should be made of the amplitude frequency and the portion of the structure that is in or near resonant condition. The direction of the amplitude and the type and mode of the vibration should be noted.

(6) Vibration loading. The input vibration load is for the vertical vehicle direction only and is 5g's from 2 cps to 50 cps. A sequence of 10 minutes' vibration time each for 2 cps, 5 cps, 10 cps, 15 cps, 25 cps, and 50 cps is required. Resonance to frequencies in

the system, if any, should also be run for 10 minutes. If resonance occurs near one of the specified frequencies, the test time at resonance frequency may be substituted for the nearby specified frequency in the sequence.

(7) Failure load. The time at which fracture, excessive yield, cracking, buckling, or collapse occurs is established as the time of failure for purposes of determining the margin of safety. The margin of safety is based on the amount of time the test specimen withstood the most severe test frequency vibration. After completion of the loading cycle, the item should be vibrated at the most severe vibration till failure. The margin of safety expressed in percent is computed as one minus the ratio of test time to failure time. If an item withstood 40 minutes at the most severe frequency, the margin of safety would be $1 - \frac{10}{40}$, or 75 percent.

(8) Modifications during test. It is the intent of Method B tests that improvements be made to the structure during the test cycle at any time. Correction of weaknesses detected by the tests should be made immediately to attain the highest possible margin of safety at the completion of tests.

b. Analysis.

(1) Force, stress, and energy. Analysis must be performed to produce the forces in the test system before, during, and after testing. Care must be taken to insure that the forces are measured and analyzed to provide for checking and balancing by the equations of equilibrium. Stress analysis to include dynamic and fatigue

methods must be accomplished. Energy analysis and transfer calculations are required, particularly where spring masses or external cushioning are inherent in the mechanical system. Due to the low and narrow range of frequencies of importance to loss and damage of highway vehicle cargoes, spectra analysis is infrequently required.

(2) Shock and vibration. It is recommended that the shock and vibration amplitudes be analyzed on an extreme value statistical basis. Of primary importance are the extreme values of the acceleration amplitudes of the high 5 percent of the readings. Manually, the data population is sampled and this sample must include a time where maximum readings were occurring. Automatic analysis frequently uses the entire amplitude data population. A threshold of 10 percent of the maximum amplitude reading is used to better shape the extreme high end of the percent occurrence curve and to exclude the low amplitude data from the percentage figures.

c. Report.

(1) Tables. Data for maximum and submaximum readings, dates, times, run numbers, and static information are required. Data from all testing should be included in the tables to indicate the size and complexity of the testing program. When several principal amplitudes of differing frequencies are recorded on the same transducer, the data for each principal frequency should be listed separately. Instrument calibration factors and other data that are not useful for technical comparison or analysis should not be included in the body of the report.

(2) Curves. Ample plots of related data are encouraged for the reports. Data that have been given in tabular form should be plotted to show a trend or comparison not readily apparent in the tables. The most basic curve used for Method B tests is the percent occurrence versus the amplitudes or magnitude of the shocks and vibrations. When several are plotted on the same graph, the amplitude comparisons are readily apparent throughout the entire frequency range.

(3) Time histories. Principal readings or key amplitudes should be plotted to show typical time histories. When the wave shape is progressively changing several time histories should be superimposed on the same plot to show progression.

6. METHOD C, IN-SERVICE SYSTEM TEST

This type of test is one where the highway vehicle load combination is run over typical highways. Shocks, vibrations, and other mechanical data are measured, and analysis is performed to extrapolate these findings to maximum conditions. Either the actual route of the shipment is used or, for special purposes, a short route of public roads simulating maximum pavement inputs is substituted.

a. Apparatus. As these tests are conducted over public roads, it is necessary that the instrumentation be contained in the same vehicle as the cargo. It is required that the apparatus be compact, light, and rugged as frequently space is a problem and the recorders are subjected to substantially the same shocks and vibrations as the cargo being tested.

(1) Route selection. The short route should be kept under 10 miles and the same route should be used for many tests to provide for direct comparison of vehicle load combination performance. The short test route should have portions of interstate, principal highways, dirt and gravel roads, and contain at least two rail grade crossings. For actual shipment tests the commercial route should not be changed for test purposes.

(2) Map and sketch. For Method C tests, a map or sketch of the route selected should be prepared. For each portion of roadway the type, maximum legal speed and the present serviceability index of the highway pavement should be shown. Any particular rough pavement determined by reconnaissance should be indicated on the map. As the surface of public roads is constantly changing, to affect shock and vibration inputs the maps must be dated and updated for each series of tests.

(3) Vehicle-cargo combination. As a Method C test is neither a fatigue nor endurance type of test, the vehicle, cargo, and restraining system should all be in excellent shape to preclude unwanted test variables. The test vehicle should contain minimum cushioning expected for vehicles anticipated to transport the cargo. If the test cargo can be transported in several configurations and groupings, the test arrangement should be selected to give the least practical cargo weight for the vehicle. The vehicle, cargo, and restraining configuration must be representative of arrangements used or intended for use in transportation service.

b. Monitoring Procedure.

(1) Preliminary measurements. Size, weight, cube, and center of gravity are required for the highway vehicle and the cargo. These measurements must be taken prior to test, as it is difficult to delay for tests either the vehicle or cargo at the conclusion or terminal location of the shipment.

(2) Static measurements. Suspension spring deflection and tire deflection from the light to the loaded condition must be measured. This can usually be obtained by before and after measurements with the actual cargo. For flatbed trailers a static deflection measurement consequent to loading of the beam deflection of the span between the kingpin and the center of the rear axles must be taken. The size and condition of the tires must be recorded and the tire pressure must be recorded before and after test.

(3) Calibrations. Transducers, springs, and all dynamometers must be calibrated prior to test. Particular attention must be given to measure the absolute amount of pretension or precompression in the restraining members prior to test.

(4) Characteristics. When possible, the vehicle and cargo used for the monitored trip should be taken to a field test site for accurate determination of mechanical characteristics. These characteristics include braking distance, tire imprints, turning radius diagrams, weights, center of gravity, and for some applications, draw bar pull.

(5) Monitoring. An engineer and an instrument technician normally accompany most monitored shipments in a separate vehicle. The instruments do not require constant attention; however, they require resetting and checking as frequently as possible to determine instrument drift or malfunction. Ideally, the shipment proceeds as a normal shipment with the monitoring readings and adjustments made during normal delays en route, driver's meal time, or terminal change overs. Notes, photographs, pertinent observations, and special studies are made by the monitoring team en route.

Over-the-Road Limitations for Various Areas of the World

Country	Weight: Metric tons	Weight: Long tons	Length: Meters	Length: Feet	Width: Meters	Width: Feet	Height: Meters	Height: Feet	Comments
EUROPE									
Austria	32	31.4946	18	59.0551	2.5	8.202	3.8	12.4673	Comb limit 38 tons max.
Belgium	36	35.4314	15	49.2126	2.5	8.202	4	13.1234	Road train limits: wt 40 tons; lgth 18 m.
Bulgaria	No Reg	No Reg	12	39.3701	No Reg	No Reg	4	13.1234	
Czecho-slovakia	40.5	39.8604	22	72.1785	2.5	8.202	3.8	12.4673	
Denmark	32.5	31.9867	18	59.0551	2.5	8.202	3.6	11.8111	Dmn favor veh and tlr.
Finland	17.5	17.2236	18	59.0551	2.5	8.202	4	13.1234	
France	38	37.3998	15	49.2126	2.5	8.202			Lgth can be exceeded to allow two-40 ft units to be carried.
Germany (Western)	38	37.3998	15	49.2126	2.5	8.202	4	13.1234	Max lgth of veh train 18 m.
Greece	32	31.4946	14	45.9318	2.5	8.202	3.8	12.4673	Max lgth for veh and tlr 18 m.
Holland	50	49.2103	15	49.2126	2.5	8.202	4	13.1234	Max lgth of veh and tlr 18 m.

Over-the-Road Limitations for Various Areas of the World

Country	Weight		Length		Width		Height		Comments
	Metric tons	Long tons	Meters	Feet	Meters	Feet	Meters	Feet	
EUROPE									
Hungary	20	19.6841	14	45.9318	2.5	8.202	4	13.1234	Max wt for a comb 36 tons and lgth 22 m.
Ireland	32	31.4946	14.933	49	2.654	8.2023	3.962	13	Comb can go up to 72 ft in lgth.
Italy	32	31.4946	14	45.9318	2.5	8.202	4	13.1234	
Luxemburg	36	35.4314	15	49.2126	2.5	8.202	4	13.1234	Max wt of comb 40 tons lgth 22 m.
Norway	Sp auth rqr for veh and tlrs.				2.5	8.202	No Reg	No Reg	
Poland	32	31.4946	14	45.9318	2.5	8.202	4	13.1234	Max lgth of comb 22 m.
Portugal	20	19.6841	12	39.3701	2.45	8.038	4	13.1234	Max wt of comb 30 tons.
Spain	38	37.3998	16.5	54.133	2.5	8.202	4	13.1234	Max lgth of veh and tlr 18 m.
Sweden	30.214	29.736	18	59.0551	2.5	8.202	No Reg	No Reg	Only 75% of main roads suitable.
Switzer-land	21	20.6683	14	45.9318	2.30	6.499	4	13.1234	Comb and road trains 26 tons and 18 m.

Over-the-Road Limitations for Various Areas of the World

Country	Weight		Length		Width		Height		Comments
	Metric tons	Long tons	Meters	Feet	Meters	Feet	Meters	Feet	
EUROPE									
Turkey	36.25	35.6774	14	45.9318	2.5	8.202	3.8	12.4673	Veh with 2 tlr 22 m.
United Kingdom	32.5135	32	15	49.2126	2.496	8.2083	No Reg	No Reg	
U.S.S.R.	40*	39.3683	24	78.740	2.5	8.202	3.8	12.4673	*On 1st class roads only.
Yugoslavia	38	37.3998	15	49.2126	2.5	8.202	4	13.1234	Max wt of comb 40 tons and lgth 18 m.
Romania	24	23.6210	15	49.2126	2.5	8.202	3.8	12.4673	
Gibraltar	20.3200	20	6.7056	22	2.1336	7	3.6576	12	
CANADA									
Alberta	32.659	32.143	19.8120	65	2.4384	8	4.1148	13.5	On dsg roads. Permits double tlr.
British Columbia	34.473	33.929	15.2400	50	2.4384	8	4.1148	13.5	On some highways 60 ft lgth.
Manatoba	33.566	33.036	19.8120	65	2.591	8.50	4.1148	13.5	
New Brunswick	33.566	33.036	18.8880	60	2.4984	8.50	4.1148	13.5	

Over-the-Road Limitations for Various Areas of the World

Country	Weight Metric tons	Weight Long tons	Length Meters	Length Feet	Width Meters	Width Feet	Height Meters	Height Feet	Comments
CANADA									
Newfoundland	33.566	33.036	16.774	55	2.4384	8	3.810	12.5	
Nova Scotia	33.566	33.036	19.8120	65	2.4384	8	3.962	13	
Ontario	33.566	33.036	18.288	60	2.4384	8	4.1148	13.5	
Prince Edward Island	33.566	33.036	24.384	80	2.4384	8	4.420	14.5	
Quebec	33.566	33.036	18.288	60	2.4384	8	4.1148	13.5*	*Dsg highway.
Saskatchewan	33.566	33.036	19.8120	65	2.4384	8	4.1148	13.5	
Yukon Territory	33.24	32.71	18.288	60	2.4384	8	4.267	14	
AUSTRALIA									
New South Wales	Various formula for calculating.		13.7160	45	2.4384	8	4.267	14	Comb 50 ft
Queensland	Various formula		13.7160	45	2.4384	8	4.267	14	Comb 50 ft
Tasmania	Various formula		13.7160	45	2.4384	8	3.810	12.5	Comb 50 ft
South Australia	32.5135	32	20.1168	66	2.4384	8	4.267	14	

Over-the-Road Limitations for Various Areas of the World

Country	Weight		Length		Width		Height		Comments
	Metric tons	Long tons	Meters	Feet	Meters	Feet	Meters	Feet	
AUSTRALIA									
West Australia	Various formula		13.7160	45	2.4384	8	4.267	14	Comb 50 ft
Victoria	Various formula		14.3256	47	2.4384	8	3.810	12.5	Comb 50 ft
New Zealand	38.6099	38	10.9728	36	2.4384	8	4.267	14	60 ft lgth permitted with permission.
REST OF WORLD									
Egypt	10.1605	10	14	45.9318	2.6	8.5833	3.5	11.5	
Hong Kong	12.1926	12	9.220	33	2.4384	8	3.200	10.5	
India	25% over manuf recm max gross wt.		15.2400	50	2.286	7.5	3.353	11	
Israel	39	38.3840	14	45.9318	2.5	8.202	3.8	12.4673	
Japan	20	19.6841	25	82.0210	2.5	8.2020	3.5	11.5	
Kenya	36.792	35.870	17.9832	59	2.515	8.25	3.810	12.5	
Morocco	35.56175	35	15	49.25	2.5	8.2020	-	-	
Philippines	Acd to formula based on axle dis.		14	45.9318	2.5	8.2020	4	13.166	

Over-the-Road Limitations for Various Areas of the World

Country	Weight		Length		Width		Height		Comments
	Metric tons	Long tons	Meters	Feet	Meters	Feet	Meters	Feet	
REST OF WORLD									
South Africa	Acd to formula based on axle dis.		15.2400	50	2.806	8.368	3.810	12.5	
Tunisia	35.56175	35	14	45.9318	2.5	8.2020	-	-	

List of Container Ships Carrying Capability

Shipping line/ships and areas served	Total 8'x8'x20' containers	No. of cranes/ capacity	Remarks
American Export Isbrandtsen Lines, Inc (AEIL) (US - Europe & Mediterranean)			
Sea Witch	928		
Sea Lightning	928		
Stag Hound	928		
Container Forwarder	738		
Container Dispatcher	738		
Export Challenger	440		
Export Champion	440		
Export Commerce	443		
Export Courier	468		
American Mail Line, Ltd (US - Pacific - Japan - Hong Kong)			
Alaskan Mail	409		
Indian Mail	409		
Korean Mail	409		
Hong Kong Mail	409		
American Mail	429		
American President Line (Worldwide)			
President Lincoln	378	1/30-ton	
President Tyler	378	1/30-ton	
President Van Buren	139	1/70-ton	
President Fillmore	139	1/30-ton	
President McKinley	139	1/70-ton	
President Grant	139	1/70-ton	
President Taft	139	1/70-ton	

List of Container Ships Carrying Capability

Shipping line/ships and areas served	Total 8'x8'x20' containers	No. of cranes/ capacity	Remarks
American Shipping Corporation (New York - Bermuda)			
Gwendolen Isle	86		
Associated Container Transportation, Ltd (ACT) (United Kingdom - Australia)			
Australian Endeavor	1,223		
Act 1	1,223		
Act 2	1,223		
Associated Steamships Pty, Ltd (Australian Coastal)			
Kooringa	276		Also cars,
Kanimbla	394		trailers, &
Manoora	394		unitized cargo
Atlantic Container Line (ACL) (US - Europe)			
Atlantic Song	452		+1,150 vehicles
Atlantic Star	452		+1,150 vehicles
Atlantic Span	452		+1,150 vehicles
Atlantic Saga	452		+1,150 vehicles
Atlantic Crown	710		+1,000 vehicles
Atlantic Causeway	710		+1,000 vehicles
Atlantic Champagne	710		+1,000 vehicles
Atlantic Conveyer	710		+1,000 vehicles
Atlantic Cinderella	710		+1,000 vehicles
Atlantic Cognac	710		+1,000 vehicles

List of Container Ships Carrying Capability

Shipping line/ships and areas served	Total 8'x8'x20' containers	No. of cranes/ capacity	Remarks
Atlantic Steam Navigation Co, Ltd (United Kingdom - Iceland - Antwerp)			
Barbel Bolten	155		
Marietta Bolten	88		
Coria	52		
Linda	52		
Curran	60		
Moyle	60		
Sandwill Merchant	45		
Sandwill Trader	48		
Sandwill Traveller	54		
Orwell Fisher	85		
Solway Fisher	85		
Australian National Line (Australia - Tasmania)			
Empress of Australia	160		16.7-ft containers
Princess of Tasmania	30		plus semitrailers,
Bass Trader	99		trailers, cars
Australian Trader	130		do
Brisbane Trader	235		do
Australian Enterprise	589		do
Bell Line, Ltd (United Kingdom - Rotterdam)			
Bell Venture	80		
Bell Valiant	80		
Bell Combat	40		

List of Container Ships Carrying Capability

Shipping line/ships and areas served	Total 8'x8'x20' containers	No. of cranes/ capacity	Remarks
Blue Star Line (United Kingdom - California & Canada)			
The Canadian Star	60		
The Colorado Star	60		
The Fremantle Star	60		
Bristol Steam Navigation Co, Ltd (United Kingdom - Iceland)			
Apollo	74		
Echo	75		
British & Irish Steam Packet Co, Ltd (United Kingdom - Ireland)			
Kildare	74		
Tipperary	74		
Frieda Graebe	45		
Hannes Knippel	45		
Rolf	47		
Wicklow	20		
Munster	35		
Leinster	38		
Innisfallen	38		
British Railways (United Kingdom - Holland - France)			
Sea Freighter 1	218		
Sea Freighter 2	218		

List of Container Ships Carrying Capability

Shipping line/ships and areas served	Total 8'x8'x20' containers	No. of cranes/ capacity	Remarks
British Yukon Navigation Co, Ltd			
Frank H. Brown	200	1 gantry/36-ton	
Klondike	200	1 gantry/36-ton	
Canadian Pacific Steamship, Ltd (United Kingdom, Rotterdam - Canada)			
Beaverbrook	135		
Eemstroom	142		
Beaveroak	150		
Beavermondo	150		
Cawoods Containers (England - Ireland)			
Craigavad	89		
Central Gulf Lines (US East Coast - Europe)			
Acadia Forrest - LASH Vessel			
Clark Traffic Service, Ltd (St. Lawrence Seaway)			
Cabot	45	1 jib/15-ton	
Chimo	45	1 jib/15-ton	
Concord Line (Chartered to Japanese Owner)			
Sylvia Cord	160		
Margret Cord	160		

List of Container Ships Carrying Capability

Shipping line/ships and areas served	Total 8'x8'x20' containers	No. of cranes/ capacity	Remarks
Containership, Ltd (United Kingdom - Scandinavia - Belgium)			
Janne Wehr	63		
Tina	63		
Lamara	40		
Costa Amaratori S.p.A. (East Coast US - Mediterranean)			
Maria Costa	50		
Pia Costa	50		
Paula Costa	50		
Dart Line (United Kingdom - Europe - US East Coast)			
Breughel	303	1 derrick/33-ton, 2 derrick/26-ton	
Jordaens	303	1 derrick/33-ton, 2 derrick/26-ton	
Jorg Kruger	202	5 derrick/25-ton, 2 derrick/45-ton	
Rubens	303	1 derrick/33-ton, 2 derrick/26-ton	
Teniers	303	1 derrick/33-ton, 2 derrick/26-ton	
DFDS (United Kingdom - Denmark)			
Manitoba	100		
Michigan	100		
Wisconsin	100		

List of Container Ships Carrying Capability

Shipping line/ships and areas served	Total 8'x8'x20' containers	No. of cranes/ capacity	Remarks
Eastern Seaboard Service (Australia - Japan)			
4 Vessels	560 each		
Ellerman Wilson Lines, Ltd (United Kingdom - Denmark - Oslo)			
Spero	100		
Sango	64		
Adda	55		
Ferrell Lines, Inc (US East Coast - Africa & Australia & New Zealand)			
American Racer	232		
American Ranger	232		
American Reliance	232		
Austral Patriot	232		
American Rover	232		
Federal Commerce and Navigation, Co.			
Federal Scheldte	100		
Federal St. Laurent	100		
Mezada	100		
Timms	100		
Atlantic Hope	100		

List of Container Ships Carrying Capability

Shipping line/ships and areas served	Total 8'x8'x20' containers	No. of cranes/ capacity	Remarks
Finland Steamship Co. (Finland - United Kingdom)			
Osternburg	42		
Iris	72		
Finlandia	90		
Finland United Kingdom Container Service (Finland - United Kingdom)			
Baltic Concord	63		
Finn Lines (Finland - United Kingdom)			
Finnarrow	168	2 derrick/34-ton	
Finnboston	168	2 derrick/34-ton	
Finncarrier	284		
Finnclipper	168	2 derrick/34-ton	
Finneagle	168		
Finnenso	168	2 derrick/34-ton	
Finnforest	168	2 derrick/34-ton	
Finnhawk	168	2 derrick/34-ton	
Finnmaid	168	2 derrick/34-ton	
France Ireland Line (France - Ireland)			
Tryo	25		
Hagno	37		

List of Container Ships Carrying Capability

Shipping line/ships and areas served	Total 8'x8'x20' containers	No. of cranes/ capacity	Remarks
Grace Line			
Santo Magdalina	175	4 gantry/20-ton	
Santo Mariana	175	4 gantry/20-ton	
Santo Mercedes	175	4 gantry/20-ton	
Santo Maria	175	4 gantry/20-ton	
Santo Luna	138		
Santo Isabel	138		
Santo Barbara	138		
Santo Clara	138		
Santo Cruz	138		
Santo Elena	138		
Great Eastern Line (India -- US - Canada)			
2 Vessels	264 each		
Grendi Tarros S.p.A. (Italy - Sardinia)			
Vento del Golfo	30		
Vento di Lenante	50		
Vento di Tramontona	160	1 gantry/25-ton	
Hamburg American (North Atlantic)			
5 Vessels	140 each		

List of Container Ships Carrying Capability

Shipping line/ships and areas served	Total 8'x8'x20' containers	No. of cranes/ capacity	Remarks
Hapag Lloyd (United Kingdom - Europe)			
Alste Express	740		
Masel Express	740		
Wiser Express	740		
Elbe Express	740		
Johnson Line (Sweden - Europe - US)			
Axel Johnson	560	2 gantry/25-ton	
Bahia Blanca	152	1 jib/25-ton	
Brasilia	152	1 jib/25-ton	
Montevidieo	152	1 jib/25-ton	
Rosario	152	1 jib/25-ton	
Santos	152	1 jib/25-ton	
Kawasaki Kisen Kaisha, Ltd (Japan - US - Australia)			
Golden Gate Bridge	716		
Australian Searoader	560		
Australian Endeavor	1,223		
Australian Enterprise	589		
Manchester Lines			
Manchester Commerce	68		
Manchester Renown	68		
Manchester City	68		
Manchester Port	110		
Manchester Progress	110		
Manchester Challenge	548		
Manchester Courage	548		
Manchester Concorde	548		

List of Container Ships Carrying Capability

Shipping line/ships and areas served	Total 8'x8'x20' containers	No. of cranes/ capacity	Remarks
Matson Line (US - Pacific - Far East)			
16 Vessels	Carry only 24-foot containers		
Mitsui Osk, Ltd (Japan - US)			
America Maru	708		
Moore McCormic Line, Inc. (US - Europe - Africa)			
Mormacaltair	292		
Mormacargo	292		
Mormacdraco	292		
Mormaclynx	292		
Mormacrigel	292		
Mormacvega	292		
Mormacisle	186		
Mormacdawn	186		
Mormacland	186		
Mormaccrio	186		
Mormacgulf	186		
Mormacsea	824		
Mormacsky	824		
Mormacstar	824		
Mormacsun	824		

List of Container Ships Carrying Capability

Shipping line/ships and areas served	Total 8'x8'x20' containers	No. of cranes/ capacity	Remarks
Nippon Yusen Kaisha (NYC) (Japan - US - Australia)			
Hakana Maru	752		
Haruna Maru	752		
Nord Deutschie Lloyd (North Atlantic)			
Bishefstein	130		
Birkenstein	130		
Bodenstein	130		
Breitenstein	130		
Bachenstein	130		
Orion Line			
Meta Reith	260	1 jib/32-ton	
Willi Reith	260	1 jib/32-ton	
Overseas Container, Ltd (OCL) (United Kingdom - Australia)			
Encounter Bay	1,300		
Moreton Bay	1,300		
Botony Bay	1,300		
Flinders Bay	1,300		
Jervis Bay	1,300		
Discovery Bay	1,300		

List of Container Ships Carrying Capability

Shipping line/ships and areas served	Total 8'x8'x20' containers	No. of crane/ capacity	Remarks
Pacific Far East Line			
Hawaii Bear (LASH ships on order)	400		
Scandinavian Container Service			
Christine Isle	86		
Sea-Land			
46 Vessels	35-foot containers only		
Sea Train (US - Pacific - Far East)			
Seatrain Carolina	170		
Seatrain Deleware	170		
Seatrain Ohio	170		
Seatrain Puerto Rico	170		
Seatrain San Juan	170		
Seatrain Washington	170		
Seatrain Louisiana	170		
Seatrain Georgia	170		
SNCF (United Kingdom - France)			
Transcontainer I	194	2 - 30-ton	

List of Container Ships Carrying Capability

Shipping line/ships and areas served	Total 8'x8'x20' containers	No. of cranes/ capacity	Remarks
States Line (US - Pacific - Far East)			
Wyoming	144		
Colorado	144		
Hawaii	144		
Idaho	144		
Michigan	144		
Montana	144		
M. M. Dant	114		
C. E. Dant	114		
California	114		
Oregon	114		
Washington	114		
United States Line			
American Lancer	1,178		
American Legion	1,178		
American Liberty	1,208		
American Lynx	1,208		
American Lark	1,208		
American Astronaut	1,208		
Yamashita Shimnikan (Japan - US West Coast)			
Kashu Maru	700		

APPENDIX 13 to ANNEX A to Staff Study (Ammunition Container Criteria)

June 1970

Ammunition Safety - Regulatory Agency Requirements

Department of Defense

AR 55-355, Joint Military Traffic Management Regulation. The transportation of military explosives by either military carriers or commercial carriers within CONUS is governed by AR 55-355. AR 55-355 requires compliance with all regulations, the completion of DD Form 626 and DD Form 836, reporting of accidents in accordance with AR 385-40, maintenance of records, tracing shipments and completion of DD Form 6 and SF 361 when required, and insuring that security is maintained. AR 55-355 gives a list of AAR loading rules applicable to safe transportation. Approved military drawings for outloading procedures will be complied with by the shipper. The use of placarding for containers is prescribed in AR 55-355.

AR 55-228, Transportation by Water of Explosives and Hazardous Cargo. Contains regulations governing transportation by water of military explosives and other hazardous materials. This regulation provides policy, procedures, and direction governing Army shipments and hazardous cargo aboard vessels including barges in CONUS territories except the Panama Canal. Where applicable and not in conflict with

local government laws or regulations of the host country, the provisions of this regulation will be implemented overseas. AR 55-228 requires that transportation of explosives and other hazardous materials comply with USCG 46 CFR 146 (CG 108) and TM 9-1300-206. It gives requirements for harbor craft service and covers the handling, loading, stowing, and unloading of explosives and hazardous materials.

TM 9-1300-206, Care, Handling, Preservation and Destruction of Ammunition. Provides information on the care, handling, preservation, and destruction of ammunition. Quantity-distance standards for manufacture, handling, storage, transport, of mass-detonating ammunition explosives and ammunition are covered. Also, quantity-distance classes and tables for all classes of ammunition and explosives are given.

DA Circular 75-1, Surface Shipment of Explosive Ammunition in Commercial Containers. This circular provides guidance for the use of commercial containers for shipment of explosive ammunition. It gives the authority to load, handle, and discharge certain classes of ammunition in compliance with 46 CFR 146.29. Shipments must not be routed through or discharged or loaded at general cargo terminals or facilities except when emergencies dictate a waiver of the basic policy. They may load or discharge at any Army or Navy facility under the direct control of the Army or Navy, provided a permit has been granted the vessel by the captain of the port.

MIL STD 129. The marking of packages will be in accordance with MIL STD 129.

AR 740-32, Technical Escort. Technical Escort unit personnel are required for shipments of chemical and biological munitions. Their services may be obtained from the U.S. Army Technical Escort Unit, Edgewood Arsenal, Maryland.

Department of Transportation

The DOT authority and responsibilities are established by Federal law in Section 831-835, Title 18, of the US Code. These regulations are published in 49 CFR, Parts 170-190; TC Georges Tariff Number 23; 49 CFR, Parts 290-297, "The Motor Carriers Safety Regulation"; and the American Trucking Association Tariff Number 14. These regulations cover minimum transportation requirements only. DOD and DA may supplement such requirements when deemed necessary. The DOT is responsible for the regulation of shipment and/or movements of all hazardous materials in interstate commerce by rail, water, public highway, and air through its operating administrations. DOT compatibility requirements are limited to the vehicle load only, while USCG compatibility requirements are for each hold in a ship. DOT regulations restrict the shipping of different types of explosives and ammunition in the same car or truck. These restrictions are specified in the loading and storage charts of explosives and other dangerous articles given in the DOT regulations.

United States Coast Guard

The USCG regulation 46 CFR (CG 108), Rules and Regulations for Military Explosives and Hazardous Munitions, provides regulations governing the classification, compatibility and storage of ammunition on board all vessels. It also gives a description, the hazard, name of commodity USCG Class, DOT Class, and DOT marking and handling required for the various classes of ammunition.

Bureau of Explosives (AAR)

Bureau of Explosives Pamphlet No. 6c, dated September 1968, contains general rules, illustrations, etc., on methods for loading and bracing trailers and less than trailer shipments of explosives and other dangerous articles via TOFC or COFC.